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OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

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MEMORANDUM

SUBJECT: ATRAZINE: Revised Occupational and Residential Exposure Assessment and Recommendations for the Reregistration Eligibility Decision Document

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This document has been updated from the preliminary version published on January 19, 2001 (G. Bangs, D269565), and the April, 2001 version revised in response to public comments (G. Bangs, D272008). Additional clarifying information and one dermal hand-press exposure study were submitted since the previous assessment. The anticipated exposures and risk estimates have been revised in light of the new information.

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Submitted Studies:

Registrant-submitted exposure-related studies:

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445976-04; 445976-05; 445976-06; 448836-01; 449580-01; 449588-01; 456223-10;
456223-11.

Agricultural Reentry Task Force (ARTF) Studies:

ARF010; ARF009; 426891; 428300; ARF023; 424281; 430627

Outdoor Residential Exposure Task Force (ORETF) Studies:

449722-01

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TABLE OF CONTENTS

| | |
|--|----|
| LIST OF TABLES | 0 |
| EXECUTIVE SUMMARY | 1 |
| BACKGROUND | 9 |
| Purpose | 9 |
| Summary of Toxicity Concerns Relating to Occupational and Residential Exposures .. | 9 |
| Acute Toxicology Categories | 9 |
| Other Endpoints of Concern | 9 |
| SUMMARY OF USE PATTERN AND FORMULATIONS | 13 |
| ASSESSMENT/CHARACTERIZATION | 17 |
| Occupational Exposures and Risks | 17 |
| Handler Exposures & Risks | 17 |
| Handler Exposure Scenarios -- Data and Assumptions | 17 |
| Study Data | 18 |
| Assumptions | 29 |
| Handler Exposure and Risk Estimate Methodology | 33 |
| Summary of Exposure and Risk Estimates: Concerns for Handlers, Data Gaps, and | |
| Confidence Levels | 35 |
| Data Gaps | 40 |
| Data Quality and Confidence in Assessment | 40 |
| POSTAPPLICATION EXPOSURES AND RISK ESTIMATES | 41 |
| Postapplication Exposure Scenarios | 41 |
| Data Sources for Scenarios Considered | 42 |
| Assumptions Used in Postapplication Exposure Calculations | 44 |
| Exposure and Risk Calculations | 45 |
| Postapplication Exposure Risk Estimates | 46 |
| Summary of Postapplication Risk Concerns, Data Gaps, and Confidence in | |
| Exposure and Risk Estimates | 47 |
| NON-OCCUPATIONAL EXPOSURES AND RISK ESTIMATES | 47 |
| Residential Handler Exposures & Risk Estimates | 48 |
| Residential Handler Exposure Scenarios -- Data and Assumptions | 48 |
| Residential Handler Exposure and Risk Estimates | 50 |
| Handler Scenarios with Risk Concerns | 51 |
| Data Gaps | 51 |
| Data Quality and Confidence in Assessment | 51 |
| Non-Occupational Postapplication Exposures and Risk Estimates | 52 |
| Postapplication Exposure Scenarios | 52 |

| | |
|---|----|
| Data Sources for Scenarios Considered | 54 |
| Assumptions Used in Postapplication Exposure Calculations | 55 |
| Postapplication Exposure Risk Estimates | 60 |
| Summary of Postapplication Risk Concerns | 61 |
| Data Gaps and Uncertainties | 62 |
| References | 64 |

LIST OF TABLES IN ATTACHMENT

1. Acute Toxicity Categories for Atrazine
2. Toxicity Endpoints for Assessing Occupational and Residential Risks for Atrazine
3. Atrazine: Occupational Exposure Scenario Descriptions and Data Sources
4. Atrazine: Occupational Handler Short-term and Intermediate-term Risk Estimates Based on Field Monitoring of Atrazine Handlers Using Engineering Controls (Biomonitoring and Passive Dosimetry Studies)
5. Atrazine: Occupational Exposure Scenario Descriptions and Data Sources Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline
6. Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Mitigation
7. Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls (Using PHED unit exposure values)
8. Summary of Occupational Short-term and Intermediate-term Handler Risks from Atrazine
9. Turf Transferable (TTR) and Dislodgeable Foliar Residue (DFR) Values from Registrant Submitted Studies (used in Postapplication Assessment)
10. Occupational Short- and Intermediate-Term Postapplication Risks for Atrazine (assessed using actual DFR values from Atrazine corn study MRID No. 448836-01)
11. Occupational Short- and Intermediate-Term Postapplication Risks for Liquid Atrazine Formulations (assessed using actual TTR values from liquid Atrazine turf study MRID No. 449580-01)
12. Occupational Short- and Intermediate-Term Postapplication Risks for Granular Atrazine Formulations (assessed using actual TTR values from granular Atrazine turf study MRID No. 449580-01)
13. Residential Exposure Scenario Descriptions for the Use of Atrazine
- 14a. Residential Short-term Handler Risks to Atrazine
- 14b. Residential Short-term Handler Risks to Atrazine at Baseline (Using ORETF Unit Exposure Values)
15. Residential Dermal Postapplication Risks for Atrazine (assessed using actual TTR values from liquid and granular Atrazine turf studies - MRIDs No. 449580-01 & 449588-01)

16. Granular Atrazine Treated Turf: Hand Press Transfer Efficiency Study Residue Data
17. Residential Oral Nondietary Postapplication Risks to Toddlers from “Hand-to-Mouth” and Ingestion Exposure When Reentering Lawns Treated with Granular or Liquid Atrazine Formulations

OCCUPATIONAL AND RESIDENTIAL EXPOSURE AND RISK ASSESSMENTS

EXECUTIVE SUMMARY

Purpose

This document presents the occupational and residential exposure and risk assessment for the herbicide atrazine. Atrazine, 2-chloro-4-ethylamino-6-isopropylamino-S-triazine, is a triazine herbicide registered to control a wide variety of annual broadleaf weeds and some grassy weeds. Registered use sites include food/feed crops, non-food crops, outdoor residential, and forestry. In agriculture, the greatest use occurs in corn, followed by sorghum, and sugarcane. It is used as an herbicide on several other crops, and is widely used on sod and selected turf grasses, including home lawns and golf courses. Atrazine is available for home use in several forms, including a “weed and feed” granular formulation and hose-end spray.

Hazard Identification

The Report of the Hazard Identification Assessment Review Committee (HIARC) for atrazine, revised April 5, 2002, indicates that there are toxicological endpoints of concern for atrazine. Based on analysis of study data submitted, residential dermal and incidental oral exposures are not anticipated to exceed 30 days duration, for handler and postapplication exposures. Occupational handler and postapplication worker exposures to atrazine are anticipated to be both short- and intermediate-term, although most agricultural handlers will probably be exposed less than 30 days per year. “Short-term” residential and occupational exposures were defined, for the purpose of this risk assessment, as 1-30 days duration, intermediate-term as one to six months, and long-term greater than six months.

For short-term dermal exposure, an endpoint was selected, based on a NOAEL of 6.25 mg/kg/day for the toxic effect of delayed preputial separation in the 30-day rat pubertal study. A dermal absorption factor of 6% (rounded up from 5.6%) was selected based on a human dermal penetration study in which 10 human volunteers were exposed to a single topical dose of atrazine. Therefore, an effective dermal NOAEL of 104 mg/kg/day is available for risk assessment by applying the 6% dermal absorption factor to the 6.25 mg/kg/day NOAEL. For intermediate-term or long-term dermal exposure, an oral endpoint was selected based on attenuation of the pre-ovulatory LH surge (indicative of hypothalamic disruption) in a subchronic study in Sprague-Dawley rats with a NOAEL of 1.8 mg/kg/day.

Due to a lack of inhalation studies, the HIARC selected an endpoint from oral studies for inhalation risk assessments. For short-term inhalation exposures, the endpoint selected was based on the delayed preputial separation in the rat pubertal study, at a NOAEL of 6.25 mg/kg/day. For intermediate and long-term inhalation exposure, the same oral study was chosen as for dermal exposure of this duration, with a NOAEL of 1.8 mg/kg/day. An absorption factor of 100% is applied for inhalation exposures.

A short-term oral endpoint was selected for incidental oral exposure in children, using a “no observed adverse effect level” (NOAEL) of 6.25 mg/kg/day based on the pubertal study in rats which showed delay in preputial separation.

Given the common endpoint of delayed preputial separation, the short term oral, dermal and inhalation exposures can be combined in an aggregate assessment. Because the dermal and inhalation endpoints for intermediate-term exposure are based on the same study, the doses for dermal and inhalation routes, when adjusted for absorption, may be added together to combine the exposures.

The target margin of exposure (MOE) of 100 or more for occupational exposure scenarios was selected based upon 10x for intraspecies variability and 10x for interspecies extrapolation. The target MOE for residential exposures is 300 or more based on a 10x for intraspecies variability and 10x for interspecies extrapolation and a FQPA Safety Factor of 3x. The FQPA Safety Factor was selected because even though there was a lack of evidence of reproductive effects, there was still a concern for developmental neurotoxic effects resulting from Atrazine’s CNS mode of action.

The carcinogenic potential of atrazine was discussed by the Science Advisory Panel (SAP) on June 27, 28 and 29th, 2000. The Cancer Assessment Review Committee (CARC) considered the comments of the SAP in meetings on November 1 and December 13, 2000. The CARC classified atrazine as “Not Likely to Be Carcinogenic to Humans. Therefore, no cancer exposure assessment has been performed in this document.

Occupational and residential incident data for atrazine have been extensively reviewed by the Agency and other epidemiological experts. For occupational cases, atrazine appears to have a less than average hazard of moderate or major effects. For cases involving children under six years of age, atrazine exposure was more likely to result in minor or moderate symptoms, but this was based on relatively few cases. Non-occupational cases showed greater evidence of hazard with higher percentages of cases with moderate and major effects as well as requirements for health care and hospitalization. Studies by the Centers for Disease Control and Prevention of apparent elevations in incidence of cancer in working populations have found no statistically significant risks.

On the list of the top 200 chemicals for which National Pesticide Telephone Network received calls from 1984-1991 inclusively, atrazine was ranked 33rd with 117 incidents in humans reported and 28 incidents in animals (mostly pets). From the review of the Incident Data System, it appears that a majority of cases involved skin illnesses such as dermal irritation and pain, rashes, and welts and eye illnesses such as eye damage, blurred vision, conjunctivitis, irritation, and pain. Poison Control Center data tend to support the Incident Data System results, as dermal and ocular effects were the most common effects reported due to occupational exposure.

Occupational Handler Exposure and Risk Estimates

The Agency has determined that there are potential exposures to mixers, loaders, applicators, and other handlers during usual use-patterns associated with atrazine. Fifteen major

exposure scenarios were identified for atrazine, including mixing, loading, and applying using aerial, ground spray, granular, fertilizer admixture, and lawn application methods. The major handler scenarios involved multiple crops and application rates, resulting in over 100 different exposure estimates. The largest agricultural use of atrazine, and the largest potentially exposed occupational population, involves the mixing, loading and application of atrazine to row crops. Most of the occupational exposure studies submitted by the registrant have measured exposure of these workers. Several studies monitored potential dermal and inhalation exposure to full time mixer/loaders and applicators in the corn belt. These studies used either passive dosimeters, urine biomonitoring, or both. All of the passive dosimetry studies reported residues in terms of the parent compound, atrazine, only. The biomonitoring studies measured urinary chlorotriazines and back-calculated atrazine dose.

The Agency also reviewed an agricultural handler study that included both passive dosimetry and biomonitoring of urinary metabolites of atrazine, and found the unit exposures were within one order of magnitude of the values in the Pesticide Handler Exposure Database (PHED) v. 1.1. The PHED is used by the Agency as a surrogate chemical database for handler exposure values. The passive dosimetry study was re-submitted by the registrant, in combination with the Agency's PHED values for ground applicators using enclosed systems. This was included as part of the risk estimates and compared to PHED-based estimates for agricultural handlers using closed systems, with reasonable agreement. Another study using biomonitoring to determine worker exposure included over 100 replicates, but did not meet adequate quality control criteria to allow the results to be related the quantity of atrazine handled. Instead, the range of daily dose per "typical" agricultural handler of atrazine in various formulations, using a variety of protective gear and application systems, confirms the findings of the other biomonitoring study and supports the overall agricultural handler risk assessment based on passive dosimetry.

Occupational and Residential Exposure Task Force (ORETF) data (where available) were used to estimate exposure and risks for Lawn Care Operators (LCOs) and some residential applicators.

Risk Estimates for Handler Scenarios

Short-term Exposure Duration

For short-term exposure estimates based on PHED data, chemical specific exposure studies, and/or ORETF data, with appropriate personal protective equipment (PPE) or engineering controls, all short-term combined (dermal and inhalation) handler exposure scenarios had MOEs greater than 100 and thus do not exceed HED's level of concern. All but five short-term handler exposure scenarios (mixing and loading large quantities of dry flowable or liquid formulations for aerial application) had MOEs greater than 100 when personal protective equipment was used. Using the ORETF study data, short-term MOEs for LCOs spraying lawns or applying granular formulations were all greater than 100 when gloves were used. Engineering control methods were only required for the highest quantity of mixing/loading in support of aircraft, and were assumed to be present for commercial fertilizer admixture. There were no exposure data for admixture of liquid atrazine with either liquid or dry bulk fertilizer, but data from a study of commercial seed treatment was used as a surrogate.

The chemical specific passive dosimetry and biomonitoring studies support the PHED assessment. In these studies, the handlers monitored for the most part used closed mixing and loading systems and enclosed cab sprayers (that is, they incorporate a mixture of PPE and engineering controls). When the daily dose was estimated from biomonitoring data and adjusted for body weight, all MOEs were greater than 100. When normalized to mg/lb ai handled, and standardized for comparison to the PHED assessment by using standard acreage (200 acres/day) and maximum application rate (2 lbs/acre), the biomonitoring MOEs range from 37-114 for 90th percentile passive dosimetry and from 64 to 250 for 90th percentile of biomonitoring. When the combined passive dosimetry/biomonitoring handler study data were merged with PHED data for the ground application methods, all of the MOEs were greater than 100 (range 170-22,000). Only the liquid and dry fertilizer admixture scenario had MOEs less than 100 in the short-term, and this is a low confidence estimate due to a lack of specific handler information.

Intermediate-term Exposure Duration

As with short-term scenarios, most of the baseline intermediate-term dermal risk estimates that had MOEs less than 100 were for mixer-loaders of liquids and dry flowable/water dispersible granules. High acreage crop liquid application, right-of-way spraying, hand-applied turf application, and the highest rate flagging scenario also had dermal MOEs below 100. As stated above, nearly all of the inhalation exposure risk estimates had MOEs greater than 100 without a respirator, with mixer/loaders of large quantities accounting for most of the higher risk estimates. Even with coveralls, gloves, and respirators, many of the mixer/loader dermal risk estimates for the larger crops, including corn and sorghum, remain above the level of concern. Only one of the intermediate-term combined route applicator risk estimates was below a MOE of 100 with maximum protective clothing: the right-of-way sprayer using the 4 lb ai/acre rate. Engineering controls raise most of the total MOEs above 100, except for mixing and loading of the largest quantities (dry flowable/WDG) of chemical handled for the highest acreage and mixing/loading liquids for fertilizer admixture. With engineering controls, all applicator risk estimates have MOEs above 100, except where not feasible (i.e., right-of-way sprayer). Intermediate-term MOEs for LCOs were all above 100 when ORETF data were used, and chemical resistant gloves were used. The right-of-way applicator risk estimates exceed the level of concern and have no known engineering controls.

Using the corn applicator study with engineering controls, no scenarios had combined MOEs less than 100. The geometric mean values of the passive dosimetry sampling from study MRIDs 441521-09/11 were used to estimate a central-tendency dose, which was appropriate for the intermediate-term exposure. The estimated mixer/loader, mixer/loader/applicator and applicator MOEs (with engineering controls for most replicates) ranged from 210-610. Intermediate-term MOEs based on the geometric mean biomonitoring data from the same study for all handlers were between 82-550 when normalized by lb ai handled, and MOEs of 330-950 were estimated by daily dose alone. The geometric mean data from the MRIDs 445976-05/06 studies were normalized to body weight and daily MOEs of 430-1600 were estimated. The registrant-submitted study (MRID 443154-4), which combined the passive dosimetry data with PHED data subsets, also provided MOE estimates greater than 100 for ground application scenarios with engineering controls.

Postapplication Worker Exposure and Risk Estimates

Most of the atrazine used in agriculture is applied to corn and sorghum early in the season, either before weeds emerge (pre-emergence) or when the crops are quite small (generally less than 12 inches high). This fact, and the degree of mechanization in cultivating these crops, minimizes the postapplication contact of workers to atrazine.

Three chemical-specific studies, one of dislodgeable foliar residue on corn, and two of transferable turf residues (TTR), were submitted to the Agency. All three were reviewed and found to be acceptable for use in the atrazine risk assessment. Wherever possible, transfer coefficients (Tcs) used in dermal exposure calculations were based upon data submitted by the Agricultural Reentry Task Force (ARTF).

Using the highest average daily foliar residues from each study at day 0-1 and the average of days 0-31 after treatment, all but one of the postapplication short- and intermediate-term dermal risk estimates were below the HED's level of concern (range 68-1,400,000). The lowest MOE, for scouting or other low intensity activities in sugarcane (68), used a combination of day 0-1 atrazine-specific corn foliar residue study data, adjusted for the 4 lb ai/acre sugarcane rate and standard assumptions for activities, which produced a screening-level exposure estimate. These assessments should also be adequate for use as range finders for the other postapplication exposure scenarios for which more data are needed, such as working with tree crops.

Residential Handler Exposure and Risk Estimates

Atrazine is labeled for resident use to control weeds in lawns, and for professional application to recreational turf and lawns. Residents or consumers applying atrazine products to their lawns may be exposed through skin contact or by inhalation. Postapplication dermal exposure to adults and children contacting treated turf is anticipated. Incidental oral (non-dietary) exposures for children playing on treated turf are also anticipated. Residential exposure durations are expected to be short-term (up to several weeks) based on the residue dissipation data. Longer, intermediate-term exposures greater than 30 days are not anticipated for dermal or inhalation routes of exposure from non-occupational sources of atrazine.

Five residential handler exposure scenarios were evaluated. The method of risk assessment for adult residential handlers was essentially the same as that for occupational workers with similar application methods. The *Draft Standard Operating Procedures (SOPs) for Residential Exposure Assessments* (1997, revised 2001) and the Outdoor Residential Exposure Task Force (ORETF) study data were compared, and the better data used to estimate exposure.

ORETF data were only available for two of the five exposure scenarios.

Risks to consumers applying atrazine by push spreader and hose-end sprayer do not exceed HED's level of concern; i.e., all MOEs for all exposure scenarios are greater than 300. However, the application scenario for belly-grinders and granular formulations applied to one-half acre resulted in a MOE of 65; spot treatment of 1000 square feet did not exceed the level of concern. Intermediate-term exposures, greater than 30 days in duration, are not expected to

occur as a result of consumers applying atrazine to lawns; therefore, risk assessments for intermediate-term residential exposures for non-occupational handlers were not conducted.

Residential Postapplication Exposure and Risk Estimates

Dermal postapplication exposure estimates were conducted using the average daily postapplication residues from each of the chemical specific turf transferable residue (TTR) studies (granular and dry-flowable formulations). Dermal transfer coefficients from the revised Residential SOPs were used. The SOPs use a high contact activity based on the use of Jazzercise to represent the exposures of an actively playing child. These assumptions are expected to better represent residential exposure and are still considered to be high-end, screening level assumptions.

High- and low-contact (e.g., playing vs. walking) activities on lawns were evaluated for dermal postapplication exposure. Two of these scenarios, both involving application of a liquid formulation, and using the highest average residue from a single study site, had short-term dermal MOEs less than 300, for high-contact activities (playing, crawling) on damp turf for the child (MOE = 110) and adult (MOE= 190). When the average residue from dry turf was used, the respective MOEs for the same activities were 620 for the child and 1000 for the adult. The highest average TTR from the (GA site) liquid application represents approximately 6% of the application rate, while the second highest average TTR (from the NC site) is about 1% of the application rate. The study authors noted that the higher residue transfer rates were associated with damp or wet turf. Therefore, these values bracket the range of residues anticipated in real-life conditions, particularly in the southeastern U.S., where atrazine is used on turf. The range of residue is also similar to those found in other pesticide TTR studies. Residues had dissipated sufficiently by the day after treatment *at all sites* to raise MOEs for children and adults to more than 300. High-contact activities on turf where granular atrazine formulations were applied did not exceed the level of concern. For adults golfing and mowing on treated turf, all short-term dermal MOEs were greater than 300, using the highest average residues. If multiple adult dermal exposures (application, golfing, mowing, high-contact activities) occurred in a single day, the combined dermal risk estimate would be no more than the lowest MOE for any single activity, and depend on the formulation applied to the turf and whether the grass is wet or dry.

Data from a granular atrazine residue hand press transfer efficiency study were used to estimate hand-to-mouth exposure from turf treated with granular formulations. The average residue of both single and multiple moistened hand presses was 1.1 % of application rate. However, there were no comparable dislodgeable residue data for spray-treated turf (because children's hands may be wet and sticky and TTR data were obtained with dry wipe methods). Therefore, the revised Residential SOPs were used to estimate incidental oral exposure for toddlers (young children) licking their fingers after touching treated turf, or mouthing treated objects or grass. Therefore, the risk estimate for hand-to-mouth is based on an assumed 5% of the application rate of 2 lbs ai/acre available as transferable residue, and formulation is not a factor (transferable residues on wet atrazine-treated turf were recorded to be as high as 6%). Only the estimated hand-to-mouth exposure after spray treatment of turf, and incidental granular ingestion, were of concern. The estimated exposures based on the granular transferable residues were not of concern. The combined (hand-to-mouth + object mouthing + soil ingestion) MOE was 190 for spray application and 750 for granular treatments. Incidental ingestion of atrazine

granules was not aggregated, as it is considered episodic in nature, but all formulations had MOEs of concern (single dose; 0.42%-1.5% ai; MOE 16-110).

It is considered reasonably likely that dermal and oral incidental exposures may occur in the same day for children playing on atrazine-treated lawn. However, both the short-term dermal and short-term hand-to-mouth exposures have MOEs (after turf is sprayed) less than 300. Aggregating the screening level, route-specific MOEs further exceeds the level of concern. Other methodologies, such as distributional data analysis, are being considered as alternatives to aggregating point estimates of risk.

Uncertainties in Risk Assessment and Data Gaps

While uncertainty cannot be completely removed from any pesticide risk assessment, there is a substantial amount of actual field monitoring data for occupational handlers of atrazine in the largest area of use, field crops. The studies support the handler exposure and risk estimates stated here, given that most of the estimates are for typical-to-high application rates and acreages per day. Less data were available for most of the other crops and the fertilizer admixture scenarios. Exposures of intermediate duration (greater than 30 days) may occur, but generally at the average, rather than maximum application rate or acreage. The postapplication risk estimates for field crops and turf are based on acceptable guideline field residue study data and are therefore of high confidence. Most of the remaining occupational postapplication risk estimates were extrapolated from those residue studies using the best available transfer coefficients, but are considered more uncertain because of the translation of residue data and transfer coefficients from one crop to another.

Residential handler exposure and risk estimates were conducted using two sets of surrogate chemical data: the ORETF study data and the Residential SOPs. The ORETF data were more complete and of higher confidence than prior studies, but some low-confidence scenarios (i.e., belly grinder) remain. Dermal postapplication exposures to atrazine were based on the highest average residues from the chemical-specific TTR study data and are of fairly high confidence. The residues were within the range of deposition found in other pesticides. Oral ingestion scenarios are based on standard assumptions and formulae (Residential SOPs) which have been recently updated, but are designed to be screening level. Granular ingestion is considered episodic in nature, and granular sizes vary greatly between atrazine-containing fertilizer formulations.

Recommendations/Data Requirements

Appropriate protective clothing to protect the skin and eyes of occupational handlers is recommended. For workers who may have extensive exposure to atrazine, skin protection should be required. Based on the estimated risks, all occupational handlers should wear chemical resistant gloves (except in cabs), and enclosed systems should be used when handling large quantities of atrazine products.

There were no specific exposure data for the treatment, mixing, loading, and application of dry and liquid fertilizers, both commercially (including cooperatives) and on-farm. Additional data or information about the fertilizer mixture methods, quantities, and usual

practices were provided by the registrant during the comment period. In addition, a seed treatment study sponsored by Syngenta was used as a surrogate for fertilizer admixture. This information helped refine the magnitude of the risk estimates. Recent information obtained from industry and research groups has helped to refine risk estimates for activities in tree farms and conifer forests but there are still data gaps in this area.

Risk estimates for residential granular application by push-spreader and postapplication exposure on granular treated turf do not exceed the Agency's level of concern. However, granular application by belly grinder to a one-half acre lawn results in a risk of concern. Therefore, application of granular formulation by hand or with hand-held devices should be prohibited by label. Current labeling should be strengthened to prevent accidental ingestion by children, and the watering-in requirement is important. The only residential postapplication exposures which exceeded the level of concern were estimated using the higher, wet turf residues from the spray application study, which were six times higher than the dry turf residues in the same study. Exposure to damp or wet turf that has been sprayed with atrazine is considered a realistic scenario, given climatic conditions in the southeastern U.S. where atrazine is most used on turf. The irrigated granular applications had the lowest residues and produced lower risk estimates.

This deterministic postapplication residential risk assessment, which used both of the atrazine TTR studies' average residue levels, resulted in some MOEs which exceed the Agency's level of concern. A probabilistic distribution of potential daily exposures would help to refine the risk estimates for aggregate exposures from multiple pathways. Guideline policies for probabilistic nondietary exposure assessment are not yet available.

OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT FOR ATRAZINE

BACKGROUND

Purpose

In this document, which is for use in the Agency's development of the Atrazine Reregistration Eligibility Decision Document (RED), the results of the review of the potential human health effects of occupational and residential exposure to atrazine are presented.

Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering treated sites after application is complete. For atrazine, both criteria are met.

Summary of Toxicity Concerns Relating to Occupational and Residential Exposures

The Report of the Hazard Identification Assessment Review Committee (HIARC) for atrazine, revised April 5, 2002, indicates that there are toxicological endpoints of concern for atrazine. Based on analysis of study data submitted, residential dermal and incidental oral exposures are not anticipated to exceed 30 days duration, for handler and postapplication exposures. Occupational handler and postapplication worker exposures to atrazine are anticipated to be both short- and intermediate-term, although most agricultural handlers will probably be exposed less than 30 days per year. "Short-term" residential and occupational exposures were defined as 1-30 days duration, intermediate-term as one to six months, and long-term as greater than six months.

Acute Toxicology Categories

Table 1 in the Appendix presents the acute toxicity categories as outlined in the Report of the HIARC, December 21, 2000. Atrazine is moderately toxic (toxicity category III) for acute oral and dermal exposures. It is less toxic (toxicity category IV) for exposure by the inhalation route, and primary skin and eye irritation, and dermal sensitization. An acceptable acute neurotoxicity study was not received.

Other Endpoints of Concern

The Report of the HIARC for Atrazine, dated April 5, 2002, identified toxicological endpoints of concern for atrazine. The doses and endpoints used in assessing the occupational and residential risks for atrazine are presented in Table 2.

For short-term dermal exposures, an endpoint was selected based on a 30-day pubertal screening study in male rats. A NOAEL of 6.25 mg/kg/day was determined, based on a delay in

preputial separation at the LOAEL of 12.5 mg/kg/day. This study is appropriate for this scenario since it demonstrates an endpoint in the young animal that is consistent with atrazine's mode of toxicity. The endpoint, delayed puberty, is relevant to the population of concern. This endpoint is appropriate to evaluate incidental oral exposures (e.g., hand-to-mouth) in children. The endpoint is a biomarker for a neuroendocrine effect and is therefore also appropriate for all age groups and both sexes for short-term exposures to atrazine.

For intermediate-term or long-term dermal exposure, an endpoint of 1.8 mg/kg/day was selected based on estrous cycle alterations and LH surge attenuation (indicative of disruption of hypothalamic-pituitary function) at 3.65 mg/kg/day (LOAEL) in a six month study in Sprague-Dawley rats. The endpoint of concern was seen after four to five months of exposure and is appropriate for this exposure period of concern. These endocrine effects are biomarkers of atrazine's potential to disturb hypothalamic-pituitary function, which may lead to various health consequences. The 21-day dermal study was not selected since estrous cycle evaluations and LH measurements (both of which have been shown to be very sensitive endpoints following atrazine exposure) were not performed in this study.

A dermal absorption factor of 6% (rounded up from 5.6%) was selected based on a human study (MRID 44152114) in which 10 human volunteers were exposed to a single topical dose of [triazine ring- U - ^{14}C] atrazine.

With the exception of an acute inhalation study, no inhalation studies are available for evaluation. Therefore the HIARC selected oral studies for inhalation risk assessments. For short-term inhalation exposures, the oral NOAEL of 6.25 mg/kg/day, described above, is applicable. For intermediate and long-term inhalation exposure, the oral endpoint of 1.8 mg/kg/day was chosen. An inhalation absorption factor of 100 percent is applied.

A urinary biomonitoring study of atrazine handlers (MRIDs 435986-04) was submitted to support the use of chlorotriazine residues to extrapolate an internal dose. The average total chlorotriazine residues excreted in the urine in the first, second, and third days after a single oral dose represented approximately 12%, 2% and 0.5%, respectively, of the total amount taken orally. The least variation between the six male subjects (chlorotriazine excreted dose = 11.6% of parent atrazine with SD of 3.35%) was seen in the first 24 hours after dosing.

Margin of Exposure (MOE)

The margin of exposure (MOE) is the ratio of the endpoint dose to the actual dose, adjusted for absorption as necessary. The MOE provides a margin between the known effect level seen in studies (usually animal) and the human exposure. The MOE is an attempt to account for variation in susceptibility between species and individuals. The HIARC selected a MOE of 100 as protective for occupational exposures. The Food Quality Protection Act (FQPA) Committee met on April 8, 2002 to re-evaluate the toxicological and exposure database for atrazine. The committee determined that a three-fold FQPA Safety Factor should be retained for atrazine when assessing residential exposures. Therefore, a target MOE of 300 is appropriate for all exposure routes for children and females of reproductive age in residential (non-occupational) settings.

Aggregate Risk Estimates

Because the short-term oral, dermal and inhalation endpoints chosen are based on the common effect of decreased body weight gain, the dose for each route may be combined. For intermediate and long-term aggregate exposures, the three routes can be combined because the dermal and inhalation exposures are corrected to oral equivalent doses and are based on the same endpoint as the reference dose (RfD).

Cumulative Risk Estimates

HED did not perform a cumulative risk assessment as part of this evaluation for atrazine because the review to determine if there are any other chemical substances that have a mechanism of toxicity common with that of atrazine has just been completed. Atrazine belongs to a class of chemicals which are called triazines and include several other herbicides, namely simazine and propazine. HED evaluated atrazine, simazine, and propazine for a mechanism of toxicity common to all three compounds and their degradates. In this document, EPA has provided an aggregate risk assessment for atrazine only.

Carcinogenicity

The carcinogenic potential of atrazine was discussed by the Science Advisory Panel (SAP) on June 27, 28 and 29th, 2000. The Cancer Assessment Review Committee (CARC) considered the comments of the SAP in meetings on November 1 and December 13, 2000. The CARC classified atrazine as “Not Likely to Be Carcinogenic to Humans.” Therefore, no cancer risk estimate has been performed in this assessment.

Incident Data

The following is a summary of an incident review by Jerry Blondell and Monica Spann of HED (2000). A number of studies and reports, by the Agency, pesticide industry, and various researchers, have investigated health incidents associated with atrazine and its metabolites. Some of the more recent reports, which attempt to explain the relative risk represented by the reported rates of incidences, are summarized here and documented in the references.

Based on occupational incident data, atrazine appears to have fewer reported cases with moderate or major effects than other major pesticides. Non-occupational cases showed greater frequency of cases with moderate and major effects as well as cases requiring treatment, but this was based on a relatively small number of cases and there was evidence that these effects may have been coincidental with rather than due to the exposure.

For incidents involving children under six years of age, atrazine exposure was most likely to result in minor or moderate symptoms. But it should be noted this was based on relatively few cases, seven children with minor symptoms and two children with moderate symptoms. Dermal and ocular effects accounted for the majority of symptoms associated with exposure to atrazine, though a number of cases also reported gastrointestinal, neurological, and respiratory effects.

California Data - 1982 through 1996

Detailed descriptions of one case submitted to the California Pesticide Illness Surveillance Program (1982-1996) were reviewed. In the case, a worker used the product to contribute to production of a commodity. Specific symptoms were not mentioned.

National Pesticide Telecommunications Network

On the list of the top 200 chemicals for which the National Pesticide Telephone Network received calls from 1984-1991 inclusively, atrazine was ranked 33rd with 117 incidents in humans reported and 28 incidents in animals (mostly pets).

Literature Review

No literature citations were found concerning poisoning incidents due to atrazine. There are a number of cancer epidemiology studies of atrazine or triazine herbicides as a group, several of which have been previously reviewed by HED.

HED concluded that none of the epidemiologic studies reviewed add significant new information concerning adverse health effects of atrazine. A non-significant elevation in non-Hodgkin's lymphoma (NHL) continues to be observed at the Louisiana plant among workers exposed to triazines, including atrazine. By itself, this study does not support a conclusion of increased cancer from exposure to triazines. However, this study could be considered supportive, but only supportive and not definitive, if evidence of an association between non-Hodgkin's lymphoma and triazine exposure was available from other studies. Follow-up by the National Cancer Institute in four states looked specifically to determine whether earlier associations in individuals studies could be attributed to atrazine when adjustment was made for exposures to other pesticides. They concluded that "detailed analyses suggested that there was little or no increase in the risk of NHL attributable to the agricultural use of atrazine" (Zahm et al. 1993). In January, 2000, Dr. Ruth H. Allen of the Agency reviewed five epidemiological studies with findings related to atrazine, including cancer incidence. The most statistically significant (odds ratio 3.00) findings related ovarian cancer and atrazine exposure among workers in a corn growing region of Italy. The findings would need to be evaluated in a larger study to confirm or refute them. Cancer is a relatively rare disease and the Italian observations are biologically of interest, despite the low number of cases. Other types of cancer in the U.S. were not found to have statistically significant correlation to atrazine exposure.

Research conducted under the National Human Exposure Assessment Survey (NHEXAS) in several states by several different researchers has included atrazine as a compound of interest in the analysis of urine from populations of children and adults. These data are still being collected and analyzed, but some preliminary published data indicate a relative rarity of atrazine in human urine taken from random population samples. One study in Minnesota (Adgate, 2001) detected atrazine in 2.3% of 262 urine samples from 89 children; a Maryland sample detected atrazine in 0.3% of 348 samples from 80 subjects over one year (MacIntosh, 1999).

SUMMARY OF USE PATTERN AND FORMULATIONS

Occupational-Use and Resident-Use Products

Atrazine, 2-chloro-4-ethylamino-6-isopropylamino-S-triazine, is a triazine herbicide registered to control a wide variety of annual broadleaf weeds and some grassy weeds. Use sites include food/feed crops, non-food crops, outdoor residential, and forestry.

Atrazine formulations are restricted to use by licensed pest control operators (PCO) or lawn care operators (LCO), except for some home lawn products with low concentrations of active ingredient which may be applied by private residents. The greatest use in agriculture occurs in corn, followed by sorghum, and sugarcane. Atrazine is also used for weed control in macadamia nuts and guava orchards, in sod production, and on conifer forests and Christmas tree farms. It is also used as a herbicide on non-cropped industrial lands and on fallow lands. Atrazine is also widely used on several non-agricultural sites, primarily on selected (mostly southern) turf grasses for fairways, lawns, or other residential turf grass. It is also registered for use as an aid in the establishment or renovation of existing conservation reserve program (CRP) acres. Atrazine may be combined with fluid fertilizers, or impregnated on dry bulk fertilizers. Resident-use (consumer) products are widely available, primarily as “weed and feed” type granular formulations, but also as a liquid for spray application.

Type of pesticide/target pests

Atrazine is a selective triazine herbicide registered to control a wide variety of broadleaf weeds and some grassy weeds such as quackgrass, barnyard grass, cheat, giant foxtail, green foxtail, crabgrass, wild oats, witchgrass, yellow foxtail, cocklebur, downy brome, Japanese brome, Kentucky bluegrass, siregrass, Flora’s paintbrush, spanish needles, marestale, groundcherry, jimsonweed, kochia, lambsquarters, annual morning glory, mustards, nightshade, pigweed, purslane, ragweed, sicklepod, velvetleaf, and wild buckwheat.

Formulation types and percent active ingredient

Atrazine is formulated for occupational use as a liquid (10 to 80% active ingredient), wettable powder (39 to 80% active ingredient), dry flowable (16 to 90% active ingredient) and a granular product (0.42 to 1.5% active ingredient). In several formulations, atrazine is combined with other active ingredients, usually herbicides, and it is also formulated with fertilizer.

Physical Characteristics

Atrazine has a molecular weight of 215.7, a low vapor pressure (3.0×10^{-7} mm Hg), is stable to photolysis and hydrolysis, and dissipates relatively slowly on foliage.

Registered use sites

Occupational-use sites

Atrazine is registered for occupational-use on corn, sorghum, sugarcane, macadamia nuts, guava, fallow lands, conservation reserve program (CRP) grasslands, roadsides, rights-of-way, conifer forests, Christmas tree farms, and selected turf grasses for lawns, fairways, and sod production.

Non-occupational-use sites

Atrazine is registered for use on lawns and turf grown in parks, playgrounds, and other residential areas. It is also used on sod farms and golf courses. Residents may apply atrazine formulations to lawns using granular or spray products.

Application Rates and Timing and Frequency of Application

Atrazine is typically applied as a preplant, preemergence, or early post emergence herbicide in agriculture. For most usages, including turf, atrazine is applied once or twice per season. With a few exceptions, outlined below, the maximum use rate for atrazine is 2.0 lbs ai/acre per application. The maximum label rates were used to estimate handler exposure.

- **Corn and Sorghum:** Label specifies a maximum use rate of up to 2 lb ai/acre per application with a maximum seasonal application of 2.5 lb ai/acre per year. Maximum of 2 applications per year.
- **Conifer Forests or Farms:** Application rates range from 2 to 4 lbs ai/acre for most weeds with a maximum of 4 lb ai/acre for quackgrass. Maximum of 1 application per year. Treatments are applied over the conifers.
- **Chemical Fallow:** Wheat-sorghum-fallow has a maximum application rate of 3 lb ai/acre, wheat-corn-fallow has a maximum application rate of 1.5 lb ai/acre and wheat-fallow-wheat has a maximum application rate of 0.75 lb ai/acre). Maximum of one application per fallow.
- **Turfgrass (spray applications):** Application rates range from 1 to 2 lb ai/acre per treatment with a maximum of two applications per year.
- **Turfgrass (granular applications):** Application rates range from 1.5 to 2 lb ai/acre per application with a maximum of two applications per year. Label suggests a usual application rate of 1.5 lb ai/acre.
- **Sod in Florida (spray application):** Application rate of 2 lb ai/acre for sandy soil and 4 lb ai/acre for muck soil for initial treatment. Follow up treatment is 1 lb ai/acre for sandy soil and 2 lb ai/acre for muck soil per treatment. Maximum of two applications per year.

- **Conservation Reserve Program Grasslands:** Application rates range from 0.75 to 2.0 lb ai/acre with a maximum of one application per year.
- **Macadamia Nuts:** Application rates range from 2 to 4 lb ai/acre per treatment. Treatments may be repeated as needed. Treatments are directed to the ground below the trees.
- **Guava:** Application rates range from 2 to 4 lb ai/acre per treatment. Maximum of three applications per year. Treatments are directed to the ground below the trees.
- **Sugarcane:** Application rate ranges from 2 to 4 lb ai/acre initial treatment with an application rate of 2 lb ai/acre for follow up treatment. Maximum of four applications per year or 10 lb ai/acre per year, with a maximum of two post emergence treatments of the cane, either over-the-top or between rows until closed.
- **Roadsides:** Minimum and maximum roadside application rate supported by registrant is 1.0 lb ai/acre with a maximum of one application per year. Special local need (SLN) labels allow highway right-of-way application of several formulations at 1-2 lbs ai/acre.

Methods and Types of Equipment used for Mixing, Loading, and Application

Atrazine is applied by aerial spray, groundboom sprayer, tractor-drawn granular spreader, rights-of-way sprayer (or other truck-mounted sprayer), low pressure handwand sprayer, backpack sprayer, garden hose-end sprayer, lawn handgun sprayer, push-type granular spreader, or “belly grinder” granular spreader. There were no chemical-specific, PHED, or other data applicable to estimate the truck-mounted sprayer exposure.

The following are the label-required PPE for agricultural atrazine products:

Mixer/loaders: long-sleeved shirt, long pants, waterproof gloves, chemical resistant footwear plus socks, protective eyewear.

Applicators, other handlers: long-sleeved shirt and long pants, waterproof gloves, chemical resistant footwear plus socks.

Duration of Exposure

Based on multiple data sources, including the EPA’s Biological and Economic Assessment Division (BEAD), USDA and California Department of Pesticide Regulation, and the Agricultural Reentry Task Force surveys, estimates of duration of exposure have been made for the uses cited above. Based on the available use information, short- and intermediate-term exposures are anticipated for occupational atrazine handlers, although the majority will probably be short-term (less than 30 days duration). The duration of exposure for each activity is important in determining the appropriate toxicological endpoint to use for a risk assessment. For corn and sorghum, the amount of time spent planting, which corresponds to atrazine exposure duration is several weeks to over one month. The registrant has submitted information supporting an average handler exposure

of two weeks per season, but many of the study participants (MRID 445976-06) apparently had exposures greater than 20 days per season, some exceeding 30 days. Little information was available for chemical weeding of sugarcane, but given the large acreages of sugarcane farms, it is anticipated that handler exposure durations of more than one week per season could occur. Lawn control operators (LCOs) are assumed to use atrazine granular or spray formulations seasonally, 1-2 times per year per lawn and may be exposed over several weeks at a time, potentially more than 30 days per year. The mixer/loaders for some larger lawn care companies supply fleets of 20 or more vehicles, thereby potentially have exposures many times that of the individual mixer/loader. Golf course mixer/loader/applicators probably will not require more than one week at a time to treat their courses, and few such courses are handled by commercial applicators. The turf use is restricted to St. Augustine and Bermuda grasses, which are limited to the southern United States and particularly Florida. Sod farmers may use atrazine more than twice per year as they raise and harvest sod continuously during the year, but it is unlikely they will apply atrazine for more than 1 week at a time. A limited amount of information was available for macadamia nuts and guava orchards, but based on their limited size, handlers are anticipated to spend less than a week at a time using atrazine. Of course, commercial handlers could cover several different crops and have exposures of several weeks in a row. For those persons, the corn and sorghum estimates will provide a high-end risk estimate. Due to limited crop-specific data, the remaining scenarios, of potentially large acreage, including Christmas tree plantations, conifer forests, and rights-of-way spraying, will be assumed to be short-term in duration. It is assumed that very large acreage (e.g., 1200 acres aerial or 200 acres ground) would not be treated daily by any single handler for more than 30 days in a season. This is based on information regarding total acreage treated from the registrant, handlers, the National Agricultural Aviation Association (NAAA), and researchers who were contacted. Therefore, mixing/loading or applying atrazine to 1200 acres per day is considered a short-term exposure. It is acknowledged that there are small growers of most crops, but this risk assessment must be inclusive of the higher exposure duration activities within each crop in order to be adequately protective of most handlers.

Consumer products are available for residents to apply to home lawns. Based on label directions, and information provided by BEAD and industry experts, atrazine is applied once or twice per year (i.e., one to two days) in the spring and/or fall. Therefore residential handlers of atrazine are anticipated to have exposures of only short-term duration.

ASSESSMENT/CHARACTERIZATION

Occupational Exposures and Risks

Handler Exposures & Risks

The Agency has determined that there are potential exposures to mixers, loaders, applicators, and other handlers during usual use-patterns associated with atrazine. Based on the use patterns, 15 major exposure scenarios were identified for atrazine:

- (1a) mixing/loading liquid formulations for aerial application,
- (1b) mixing/loading liquid formulations for groundboom application,

- (1c) mixing/loading liquid formulations for rights-of-way sprayer application to roadside,
- (1d) mixing/loading/incorporating liquid formulations onto dry and liquid bulk fertilizer (commercial off-farm technique)
- (1e) mixing/loading/incorporating liquid formulations into dry bulk fertilizer (on-farm technique),
- (2a) mixing/loading dry flowable formulations for aerial application,
- (2b) mixing/loading dry flowable formulations for groundboom application,
- (2c) mixing/loading dry flowable formulations for rights-of-way sprayer application to roadside,
- (3) loading granular formulations,
- (4) applying liquids with aircraft,
- (5) applying liquids with groundboom sprayer,
- (6) applying liquids to roadsides with rights-of-way sprayer,
- (7) applying with a lawn handgun or compressed air sprayer,
- (8) applying impregnated dry bulk fertilizer with a tractor-drawn spreader,
- (9) applying granular formulations with a tractor-drawn spreader,
- (10) mixing/loading/applying with a backpack sprayer,
- (11) mixing/loading/applying liquid formulations with a low pressure handwand,
- (12) mixing/loading/applying liquids, dry flowables, or wettable powders in water soluble bags with a lawn handgun or compressed air sprayer,
- (13) loading/applying granulars with a push type spreader,
- (14) loading/applying granulars with a bellygrinder, and
- (15) flagging for aerial spray applications.

Handler Exposure Scenarios -- Data and Assumptions

Occupational handler exposure assessments are evaluated by the Agency using a baseline clothing exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve a margin of exposure (MOE) which does not exceed the Agency's level of concern (see Toxicity Section). All of the submissions to the Agency have been reviewed and considered in preparing this risk assessment. The studies have been reviewed separately and are referenced in this document, with summaries appearing below. The assumptions used to calculate exposure estimates follow the study reviews.

Study Data

Agricultural Uses: The largest use of atrazine, and the largest potentially exposed worker population, involves the mixing and loading of formulation and spraying of row crops. Most of the occupational exposure studies submitted have measured exposure of these workers. These studies are described in detail below. The Novartis [now Syngenta] exposure data was collected from several studies in the corn belt monitoring potential dermal and inhalation exposure to full time mixer/loaders and applicators. Studies used either passive dosimeters, urine biomonitoring, or both. All monitoring studies, except biomonitoring, reported residues in units of the parent compound, atrazine, only. The biomonitoring studies measured urinary chlorotriazines and back-calculated atrazine dose. One dosimetry study was submitted and reviewed by the Agency prior to this risk assessment, and was re-submitted in combination with the Agency's Pesticide Handler Exposure Database (PHED) values for ground applicators using enclosed systems. This was included as part of the risk estimates and compared to PHED-based estimates for agricultural handlers using closed

systems, with close correlation. The Agency also reviewed an agricultural handler study (MRIDs 441521-09, -11) that included both passive dosimetry and biomonitoring of urinary metabolites of atrazine. Another study using biomonitoring to determine worker exposure (MRIDs 445976-05, -06) included over 100 replicates, but had significant study design and quality control issues. The PHED is used by the Agency as a surrogate chemical database for handler exposure values (see Table 3).

Agricultural Handler Study Summaries:

Handler studies incorporating biomonitoring

The following six citations were reviewed by contractor and the Agency and a summary of the review follows.

MRID 439344-17. *Evaluation of the Potential Exposure of Workers to Atrazine During Commercial Mixing, Loading, and Spray Applications to Corn. Biological Field Phase.* Honeycutt, R., Bennet, R., and DeGeare, M. (1996). HERAC, Inc. No. 95-501HE. Ciba Study No. 178-95. Unpublished study prepared by Ciba Crop Protection [now Syngenta]. 839 pages.

MRID 439344-18. *Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn. Interim Report.* Selman, F. (1996). Lab Project Number: ABR-95133: 101930: 178-95. Unpublished study prepared by Ciba-Geigy Corp.[now Syngenta] 64 pages.

MRID 441521-09. *Evaluation of the Potential Exposure of Workers to Atrazine During Commercial Mixing, Loading, and Spray Applications to Corn. Final Report.* Selman, F.B. and L. Rosenheck (1996). Lab Project Number: ABR-95133. Unpublished study prepared by Ciba Crop Protection [now Syngenta]. 199 pages.

MRID 441521-11. *Evaluation of the Potential Exposure of Workers to Atrazine during Commercial Mixing, Loading, and Spray Application to Corn (EPA-Subpart U) -- Biological Field Phase. Final Report.* Honeycutt, R.C., Bennett, R.M. and DeGeare, M.A. (1996). Lab Project Number: 178-95: 95-501HE: 95-517. Unpublished study prepared by Ciba Crop Protection [now Syngenta]. 687 pages, 2 volumes.

MRID 443154-03. *Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn (MRID 441521-09). Amendment 1.* Selman, F.B. and L. Rosenheck (1996). Laboratory Project Number ABR-95133. Unpublished study prepared by Novartis Crop Protection, Inc.[now Syngenta] 29 pages.

MRID 443154-04. *Presentation of Data from ABR-95133 "Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn" from Use in the Pesticide Handler's Exposure Database (PHED 1.1).* Selman, F.B. and L. Rosenheck (1996). Laboratory Project Number ABR-97068. Unpublished study prepared by Novartis Crop Protection, Inc.[now Syngenta] 97 pages.

This study was conducted by Ciba-Geigy Corporation (now Syngenta) and was submitted to the Agency in several phases including interim reports, final reports, and amendments. The study monitored dermal and inhalation exposure experienced by workers during mixing, loading, and applying various atrazine-containing products to corn using ground boom sprayers. The study used passive dosimeters, air sampling, and biomonitoring of urine metabolites to determine daily workers exposures to atrazine. See **Table 4**.

Data were collected at 19 test locations: five in Illinois, five in Indiana, and nine in Ohio. Individual test "sites" consisted of either multiple fields treated with atrazine or commercial facilities where atrazine was loaded into carrier trucks or spray rigs.

Eighteen subjects (17 males, 1 female) were monitored, and one male subject was monitored twice, yielding nineteen replicates. Workers were monitored using dermal and inhalation dosimetry during the first two days of handling atrazine, while urine samples were collected prior to initiation of this study and during all three days of each monitoring period.

Applicators were responsible for driving the spray rigs, applying atrazine, and conducting maintenance of the spray rigs and booms. In addition, applicators occasionally cleaned spray rigs and coupled hoses from the trucks to the rigs. Applicators had between 3 and 15 years experience making pesticide applications. Of eleven applicator subjects, four were mixer/loader/applicators who handled and applied atrazine over a three day period while the remaining seven applied atrazine over a two day period. All but one of the applicators used closed cab tractors and all used groundboom sprayers. All mixer-loader/applicators used closed cab tractors and closed system mixing and loading except one who used open mixing and a closed cab sprayer.

The mixer/loaders dispensed atrazine products from bulk supply tanks into large nurse trucks using electronic valves and metering devices. When required, they would empty pesticide bags or jugs into the trucks to mix the spray solutions. The truck tenders were responsible for coupling and uncoupling hoses to and from trucks, driving the trucks, coupling truck hoses to spray rigs, and conducting occasional maintenance on the trucks and the rigs. All mixer-loader/truck tenders used closed mixing systems, except two who used open pour.

Clean protective clothing was worn by each test subject each day. The test subjects wore long sleeved shirts, long pants, leather boots and caps and some wore sweatshirts. Mixer/loaders and truck tenders also wore nitrile gloves and goggles.

A variety of commercial atrazine-containing products were used in the study. They are usually sold in bulk, mini-bulk, open pour containers, or bagged quantities, and are applied by commercial applicators only. The amount of atrazine in the end-use products ranged from 10.4 percent to 85.5 percent. Other active ingredients in these formulations include metolachlor, acetochlor, cyanazine, and dimethanamid. Atrazine application rates ranged from 0.95 to 1.98 lbs ai/acre (mean= 1.4 lbs ai/A). The amount of atrazine sprayed for each replicate (over 2 or 3 day period) ranged from 148 lbs to 3,450 lbs of atrazine. Total acres treated per replicate (over 2 or 3 day period) ranged from 138 acres to 1,618 acres.

Dermal exposure was quantified using: (1) inner and outer body dosimeters, (2) hand rinses, and (3) head patches. Inner body dosimeters including cotton undergarments (T-shirts (or bra) and briefs) were used to quantify dermal exposure to atrazine penetrating the workers' outer clothing. Outer body dosimeters consisted of 60/40 cotton: polyester blend, long-sleeved shirts and 100 percent cotton long pants. For replicates 1 to 10, sweatshirts (50/50 cotton:polyester blend) were used as outer dosimeters, and the long-sleeved shirts as inner dosimeters. Outer dosimeters were then sectioned for analysis.

Hand rinses were conducted both in a 200 ml detergent solution and in 200 ml distilled water. Head patches consisting of 16 ply 4 inch by 4 inch gauze with a cellulose backing were used to quantify face and neck exposure to atrazine. Two patches were pinned to a cap, one to the front, and one to the back. A face and neck surface area of 910 cm² was used for calculation of exposure.

Inhalation exposure was measured using personal air sampling pumps connected to Gelman mixed cellulose-ester filter-cassettes (for aerosols and particulates) and Chromosorb 102 vapor collection tubes (for vapors). The air flow rate was approximately 1.0 liter per minute. Pumps ran all day, from when subjects dressed, to their return from the field.

Two pre-screen urine samples, each covering a 12-hour interval (0-12 hour, and 13-24 hour), were collected from each participating subject prior to the study except for five volunteers. For these five test subjects, urine samples were obtained just prior to initiation of the study.

Urine samples were fortified with analytical grade atrazine and the expected four degradation products. One group of samples was stored under ambient conditions and one set was stored on wet ice. The recovery for the 120 hour ambient sample was 104 percent of the recoveries at time 0, and the recovery for the 120 hour wet ice sample was 85 percent of the time 0 wet ice samples.

Dermal and inhalation dosimetry samples were analyzed using mass spectrometric detection. The method used for urine biomonitoring analysis was a proprietary method (i.e. Novartis Analytical Method AG-637), which had previously been submitted to EPA in 1996 and validated in 1998.

Laboratory recovery data were collected concurrently with the field samples. Average recoveries from all matrices (e.g., dosimetry, air sampling media, hand rinses) ranged from 72 percent to 110 percent. Laboratory recoveries from urine averaged as follows: 107 percent for atrazine, 104 percent for G-30033, 106 percent for G-28279, and 91 percent for G-28273.

For dermal and inhalation exposure, fortified field matrix samples were prepared on twelve separate days throughout the study. The stock solution was prepared that day from aliquots of the pesticide formulation collected from the bulk storage tanks at the test-sites.

The fortified field matrix recoveries were quite inconsistent. Field fortification levels for the dermal dosimeters ranged from 5.8 micrograms up to 48,000 micrograms. Field recoveries ranged from 21.9 percent to 230 percent. Fortification levels for the hand rinses ranged from 13 micrograms to 4,800 micrograms. The field

recoveries for the hand rinses was 17.6 percent to 153 percent. The fortification levels for the inhalation media ranged from 1.16 micrograms to 120 micrograms. The field recoveries for the airborne samples was 22.6 percent to 254 percent for the Gelman air filters and 57.6 percent to 112 percent for the Chromosorb tubes.

Fortified urine and control urine samples were prepared using aliquots of control urine spiked with analytical grade atrazine and four degradation products (atrazine mercapturate, G-30033, G-28279, and G-28273). Average recoveries ranged from 97 percent to 120 percent.

Three sets of data are reported in the study: (1) dose as a function of inhalation monitoring and dermal dosimetry data, (2) dose predicted from urinary concentration, and (3) dose predicted from surrogate pesticide exposure data (i.e., PHED). The authors used the following assumptions to calculate exposure:

- each worker handled 6,000 lbs atrazine per year for the purposes of calculating an average daily dose (ADD);
- each worker weighed 70 kg and had a 35 year exposure to atrazine over a 70-yr lifetime;
- the three chlorotriazine metabolites represented total chlorotriazines in urine;
- a dermal absorption value of 5.6 percent was selected by the registrant; and
- an adjustment factor ($100/12$) was used when calculating atrazine dose from urine, based on a monkey and human studies. This indicates that 12 percent of an atrazine dose could be accounted for in 0-24 hour urine samples as total chlorotriazine metabolites.

The internal “unit exposure” atrazine value calculated from urine data was derived by summing total chlorotriazines exposure per monitoring period multiplied by the adjustment factor ($100/12$) and dividing the result by the total pounds of atrazine handled in the monitoring period. Only the three chlorotriazine metabolites (G-28273, G-28279, and G-30033) were combined to calculate the atrazine dose.

Dermal exposure was calculated from residue levels representing “exposure to the skin.” Inner layer dermal dosimeter values were used whenever possible. A 10 percent penetration factor, was used to calculate inner layer exposure values where these values were missing. The calculated dermal values were then combined with hand rinse and head patch data to give total atrazine exposure. Next, the inner layer residue values were multiplied by the registrant selected dermal absorption factor (5.6%) to yield absorbed dose. Inhalation exposure was estimated by multiplying the monitored air concentration by 29 liters per minute, and dividing by the total amount of atrazine handled. An inhalation absorption factor of 100 percent was assumed.

The data submitted in the study of worker exposure to atrazine meet most of the criteria specified by the U.S. Environmental Protection Agency’s (US-EPA) OPPTS Series 875, Occupational and Residential Exposure Test Guidelines, Group A: Applicator Exposure Monitoring Test Guideline (875.1100, Dermal exposure: outdoor; 875.1300, Inhalation exposure: outdoor; 875.1500, Biological monitoring).

- Exposure data were not corrected for field, storage, or laboratory recovery rates. Field fortification recoveries were highly variable. This variability may be due to non-homogeneity of the pesticide suspensions sampled. The study suggests that this variability in the field fortification recoveries is most likely due to the use of formulated material sampled from bulk containers for spiking, since that as the suspension is serially diluted, any non-homogeneity is amplified with each step.
- Another significant issue was the choice of urinary total chlorotriazine residues for biological monitoring. The chlorotriazine residues represent only 12% of total atrazine dose. It is HED policy that the predominant metabolite be used as the indicator for calculating the parent chemical, thereby reducing the error potential when back-calculating the dose. It is preferable to use a metabolite which represents 30% or more of the original dose, in order to reduce statistical error. The primary metabolite is atrazine mercapturate, which has been used in other monitoring studies, including the current National Hazardous Exposure Assessment Survey (NHEXAS). The authors state that at the time of the study they were limited to the chlorotriazine residues due to a lack of an analytical method for atrazine mercapturate. Also, urine creatinine and creatinine clearance were not measured. Without these measures, there is no way to verify the accuracy of the volume of urine collected during biomonitoring (which is critical to calculating the total dose absorbed).
- Five of the subjects handled simazine products as well as atrazine. Simazine interferes with quantification of atrazine and its metabolites in urine. It is not known whether cyanazine also interferes.

- Calibration of some of the application equipment was not performed.

The study presented the following results.

Applicators: Seven applicators were monitored for two days (dermal dosimetry and inhalation monitoring), which resulted in 14 passive dosimetry replicates. At least three of these applicators had spill-related exposure. The total dose (i.e., dermal + inhalation) ranged from 2.10×10^{-2} to 6.42×10^{-5} mg/lb a.i. (geometric mean of 7.71×10^{-4} mg/lb a.i.). Urinary residues indicated an oral equivalent dose ranging from 7.87×10^{-3} to 8.61×10^{-5} mg/lb a.i. (geometric mean of 6.05×10^{-4} mg/lb a.i.). By comparison, the PHED dose estimate was 2.67×10^{-4} mg/lb a.i., assuming closed cab, ground boom application, long pants, long sleeves, and no gloves.

Mixer-Loader/Truck Tenders: Seven mixer-loader/truck tenders using closed mixing systems and one using an open system were monitored for two days (dermal dosimetry and inhalation monitoring), which resulted in 14 passive dosimetry replicates. The total dose (i.e., dermal + inhalation) ranged from 1.63×10^{-2} to 1.49×10^{-5} mg/lb a.i. (geometric mean = 7.34×10^{-4} mg/lb a.i., excluding MLA-20 who used an open mixing system). Urinary residues indicated an oral equivalent dose ranging from 2.53×10^{-3} to 2.76×10^{-5} mg/lb a.i. (geometric mean = 3.77×10^{-4} mg/lb a.i.). By comparison, the PHED dose estimate was 6.68×10^{-4} mg/lb a.i., assuming closed mixing/loading systems, long pants, long sleeves, and gloves.

Mixer-Loader/Applicators: Three mixer-loader/applicators using closed mixing/closed cab systems and one using an open mixing/closed cab system were monitored for two days (dermal dosimetry and inhalation monitoring), which resulted in 6 passive dosimetry replicates. The total dose (i.e., dermal + inhalation) ranged from 1.55×10^{-2} to 1.68×10^{-5} mg/lb a.i. (geometric mean of 1.29×10^{-3} to 1.03×10^{-3} mg/lb a.i.). Urinary residues indicated an oral equivalent dose ranging from 1.03×10^{-3} to 4.59×10^{-3} mg/lb a.i. By comparison, the PHED-based dose was 9.35×10^{-4} mg/lb a.i.

The study also presented Lifetime Average Daily Dose (LADD) values. These results are not presented here because there is currently no cancer concern with atrazine.

Apparently the PHED data were subsetting in a manner that was not explained in the study report. Therefore, the results were lower than HED's estimates using closed mixing and loading or enclosed cab spraying with a ground boom. The HED also attempted to calculate the passive doses and urinary excreted doses using the data from the studies. The HED calculations were within the higher range of the study authors' values, and agreed closely with PHED-based calculations for scenarios using engineering controls. This is discussed further in the risk estimates section.

The following two citations were reviewed by contractor and the Agency and a summary of the review follows.

MRID 445976-05. *Evaluation of the Potential Internal Dose of Atrazine to Workers During Mixing-Loading and Application of Atrazine Products – Biological Monitoring.* Selman, F.B. (1998). Novartis Laboratory Number 179-95. ABR-97094. Unpublished study prepared by Novartis [now Syngenta]. 182 pages; and

MRID 445976-06. *Evaluation of the Potential Internal Dose of Atrazine to Workers During Mixing-Loading and Application of Atrazine Products – Biological Field Phase.* Honeycutt, R.C. and M.A. DeGeare. (1998). Novartis Laboratory Number 179-95. Unpublished study prepared by Novartis [now Syngenta]. 912 pages.

This study was submitted to the Agency in two reports. The purpose of the study was "to determine the amount of atrazine that individuals who mix, load, and apply atrazine are exposed to during commercial treatment of corn" in the course of realistic normal daily activities. The study focused on the biomonitoring of metabolites of atrazine in urine samples. However, the authors stress that this study was "not designed to be the

traditional Subdivision U worker exposure study.” The basic premise of the study was the assumption that worker exposure values obtained reflected steady-state exposure conditions.

This study consisted of an analytical component and a biological field component. The analytical phase was managed by Novartis Crop Protection (now Syngenta, formerly Ciba-Geigy) and the biological field phase (urinary biomonitoring and an atrazine seasonal usage survey) was managed by HERAC, Inc. The study began in March 1995 with urine samples being taken through June of 1995. These samples were analyzed two years later in April, 1997. The analytical phase report was completed June 29, 1998.

Sixteen end-use products were used by study subjects. All are usually sold in bulk, mini-bulk, open pour containers, or bagged quantities, and are applied by commercial applicators only. The identity, strength, purity and composition of each end-use product was not independently analyzed; products used were commercial formulations obtained from the open market. The percent atrazine ranged between 10 percent and 85.5 percent. Most end-use products (14/16) contained varying percentages of one of the following herbicides: metolachlor, bromoxynil, alachlor, acetochlor, cyanazine, bentazon, dicamba, propachlor, and dimethanamid.

Application rates ranged between 0.14 lbs ai/A and 2.01 lbs. a.i./A (average = 1.3 lbs a.i./A). [The maximum pre-emergent application rate for atrazine is 2.0 lbs a.i./A; the annual treatment limit is 2.5 lbs a.i./A.] Applications were performed with groundboom sprayers by experienced applicators (mean: 8 years experience; range: 0.25 to 40 years). All but four applicators used closed-cab application equipment. In those four instances, open-cab tractors with trailing groundboom sprayers were used.

Use information was identified by “spray tickets” provided by the commercial applicator facilities. Spray tickets contain information on the product applied as well as the application rate on a given date, and identify the applicator receiving an allotment of atrazine for later application at a farm. Data were available for 107 volunteer subjects.

The number of test subjects is inconsistently reported within the study. The Analytical Phase report indicated that 122 individual subjects monitored (with 9 monitored twice) yielding 131 replicates. The Biological Field Phase report indicates the original 131 subjects were distributed as 15 mixer/loaders, 96 mixer/loader/applicators, 10 applicators, 6 truck tenders, and 4 mixer/loader/truck tenders. Appendix 3 of the Analytical Phase Report reports personal information for 130 study subjects and indicates that 10 subjects were monitored twice, no urine samples were obtained from 2 subjects and one subject did not handle atrazine. This would indicate that 117 test subjects participated ($130 - 10 - 3 = 117$). Appendix 7 of the Analytical Phase Report, “Summary of Atrazine Seasonal Use Data,” lists 107 volunteer subjects for which seasonal atrazine use data were available including 9 mixer/loaders, 83 mixer/loader/applicators, 9 applicators, 2 truck tenders, 4 mixer/loader/truck tenders.

Similarly, the number of urine sample replicates is inconsistently reported. The Analytical Phase report states that 91 urine sample replicates from five states were analyzed (15 to 22 samples from study sites in Indiana, Ohio, Iowa, Illinois, and Nebraska). The Biological Field Phase report indicated that 138 urine sample replicates were collected (127 complete samples plus an extra 11 replicates). Of these, 35 were disqualified (19 due to lack of verified atrazine use and 16 because atrazine was definitely not handled concurrently with urine collection. This yielded 103 urine sample replicates for analysis. Appendix 9 of the Analytical Phase report lists 125 replicates.

A urine sample “replicate” is defined as all urine collected during “the period of time from initiation of the first urine sample for a volunteer through sampling of the last urine sample from that volunteer.” Workers were sampled over varying periods of time, and a urine sample replicate grouping always involved numerous individual analyses (e.g., for one worker, a replicate grouping consisted of 18 separate urine analyses over the time period). Two random urine pre-screening urine samples were collected from most test subjects prior to the start of their 1995 spray season. However, the authors stated that it was “possible that the volunteers could have been working with atrazine before or during this pretrial period.”

Test subjects handled atrazine from one to seven consecutive days, with most test subjects handling atrazine one (25.2 percent), two (27.2 percent) or three (28.2 percent) days. No attempt was made to standardize clothing worn by subjects or to alter or interfere with any subject’s normal work practices. Subjects typically wore various combinations of rubber or leather work boots, chemical resistant gloves, and goggles (mixer/loaders and truck tenders only), long sleeved shirts, long pants, and jackets.

The study was conducted in compliance with most OPPTS Series 875 Occupational and Residential Exposure Test Guidelines, Group A: Applicator Exposure Monitoring. The most significant study quality issues follow.

- Potential interference from other active ingredients was not addressed. This is significant since handlers used sixteen different atrazine products, fourteen of which contained substantial percentages of one of eight other herbicides, and two of which contained another triazine (e.g., cyanazine).
- Formulation sample aliquots or tank mix aliquots were not analyzed.
- The number of test subjects that were actually monitored in the study is unclear.
- Pre-screen urine samples were not obtained for all test subjects. Further, creatinine was not analyzed in the urine samples, preventing evaluation of the completeness of the 24-hr urine samples.
- Analytical data for two of the three atrazine metabolites quantified were not corrected for laboratory storage recovery, which ranged between 57 percent and 78 percent.
- An incomplete set of the field collected urine samples were analyzed (91 samples analyzed out of 103 qualified samples).

Overall quality assurance / quality control techniques were acceptable. Sample storage and handling procedures were acceptable. No formulation tank mix samples were analyzed. The analytical method used was proprietary (i.e., Novartis Analytical Method AG-637), which had been submitted to The Agency in 1996 and validated in 1998. The level of detection (LOD) was 0.05 ng for each analyte. The level of quantification (LOQ) was 1.0 ppb for atrazine and G-30033 and 2.0 ppb for G-28279 and G-28273.

A proprietary method (Novartis AG-637) was used to quantify three atrazine chlorometabolites in urine samples. The daily dose for atrazine was calculated by combining the highest level found of the three chlorometabolite levels (ng/g x grams urine) found during any single 24-hour monitored period, multiplied by a 100/12 accountability factor derived from human and animal metabolism studies. This value was divided by the subject's body weight. The Average Daily Dose (ADD) was calculated by multiplying the Atrazine Daily Dose times an assumed spray season of 30 day/year and divided by 365 days/yr. The Lifetime Average Daily Dose (LADD) was calculated by multiplying the ADD times (35 years/70 year lifetime).

The study did not correct G-30033 and G-28279 data for laboratory, storage, or field recovery losses, however, a correction factor of 0.75 was applied to G-28273 data. This factor was reportedly derived from the "average recovery... across all four sets of stability data..." and was calculated by averaging: 1) field fortification recovery (77 percent); 2) stability after 120 hours exposure to ambient (85.5 percent) or wet ice (77.5 percent) conditions; 3) laboratory storage recovery (57 percent at Day 730); and 4) stability of "incurred" residues (75 percent).

The study used submitted data from monkey (one IV and one oral) and human (one dermal and one oral) dosing studies to determine the most appropriate factor to apply to total chlorotriazine residues in 0-24 hour urine samples to calculate the internal dose of atrazine. The study reported that parent atrazine was generally non-detectable in urine after dosing. Therefore, the study did not include atrazine with chlorotriazine metabolites in those samples where it was detected in urine, since its presence in urine was likely to be artifactual or due to sample contamination. Only the oral dosing studies proved useful and there was some agreement between monkey and human oral studies. The three chloro degradation products of atrazine (G-30033; G-28279; G-28273) were found to represent between 11 percent and 12 percent of the total dose excreted in 0-24 hour urine samples. The correction for the various molecular weights relative to the parent compound, atrazine, was included in the percent excretion in urine calculated by Cheung, et al.

Atrazine daily dose was calculated by combining the highest level of the three chlorotriazine metabolite levels (ng/g x grams urine) found during any single 24-hour period (after dividing the G-28273 data by 0.75), multiplied by the 100/12 accountability factor, to yield mg/day, then dividing by the body weight of the subject. No attempt was made to subtract a background atrazine level since the study premise was to measure steady-state urinary atrazine metabolite levels. The atrazine daily dose value was then converted to an ADD by assuming a spray season consisted of 30 days of exposure per year (365 days). The ADD was multiplied by 35/70 to account for number of years worked and years of life.

The study reported the following findings.

- Of the samples analyzed, 6 percent contained atrazine residues. Since atrazine is metabolized and not present in urine, it was assumed that this finding was due to poor personal hygiene.
- None of the workers handled atrazine products continuously throughout the spray season.
- Open-cab application was practiced by only two of the subjects and their exposures were of similar magnitude to that from closed cab applicators. These data were pooled.

- The Average Daily Dose ranged from 3.98×10^{-4} to 6.37×10^{-3} mg/kg/day for applicators, 5.73×10^{-4} to 3.84×10^{-2} mg/kg/day for mixer/loader/truck tenders, and 4.67×10^{-4} to 4.91×10^{-2} mg/kg/day for mixer/loader/applicators.
- The Lifetime Average Daily Dose (LADD) was 0.62×10^{-4} mg/kg/day for applicators, 1.81×10^{-4} mg/kg/day for mixer/loader/truck tenders, and 2.38×10^{-4} mg/kg/day for mixer/loader/applicators.

The HED reviewers recalculated the absorbed daily dose using the mean daily maximum exposure for individual workers and each job category (i.e., mixer/loader, applicator, and mixer/loader applicator). Most replicates (n = 96) fell into the mixer/loader/applicator category. The amount of ai handled per day, calculated by the authors, varied from a minimum of 4.5 lbs to a maximum of 772 lbs for mixer/loaders, and average amount ai handled ranged from 133 lbs for applicators to 241 lbs for mixer/loaders. On review, the amount of ai handled, based on actual “spray tickets” reported ranged from 4.5 to 770 lbs ai per day for mixer/loaders, from 58 to 310 lbs ai per day for applicators and from 45 to 364 lbs ai per day for mixer/loader/applicators. As indicated by the amounts handled per day, the dose was not found to be “steady state,” as suggested by the authors. Also, due to collection of 24 hour urine samples during the spray season, it was not possible to determine the relationship between the amount handled on a given day and the chlorotriazines excreted the following day. The mean 90th percentile daily dose was selected to represent a daily dose for each category. This is considered a reasonable, yet high daily value as the study monitored actual work practices without influencing amounts of atrazine handled. The HED calculation showed internal doses of 0.012 mg/kg/day for mixer loaders, 0.0038 mg/kg/day for applicators, and 0.014 mg/kg/day for mixer/loader applicators. These doses are within the same range as the study findings. The HED calculation is only approximate, however, because during the study, atrazine was handled on consecutive days (or not at all), and atrazine is excreted in the urine in quantifiable amounts for at least 3 days after exposure. Some of the highest daily doses were based on days when little or no atrazine was handled. Therefore, there is both the “lag time” to excretion, and the additive nature of consecutive daily doses. Use of the single 24-hour excretion correction of 12% for chlorotriazines does not correct for either of these major confounding factors. Atrazine metabolites continue to be excreted for several days after exposure, so measuring the daily excretion only provides data about the body burden at that time. Therefore, for the purpose of interpreting this study, the mean to 90th percentile of the maximum doses are considered most representative for each job category for calculating MOEs for handlers. Although the dose per reported pounds ai handled was also calculated, for the purpose of comparison to PHED computations, this number has greater uncertainty than using the actual daily dose based on study data alone. See Table 4 for estimates of exposure and MOEs based on the uncorrected field data. It is notable that some of the study subjects reported handling atrazine more than 30 days per year, generally between April and June.

In the report entitled *Presentation of Data from ABR-95133 “Assessment of Potential Worker Exposure to Atrazine During Commercial Mixing, Loading, and Application to Corn” for Use in the Pesticide Handler’s Exposure Database* (MRID 443154-04), Novartis added the data from MRID 441521-09 to their copy of PHED V 1.1. The resulting unit exposure values (i.e., PHED V1.1 plus additional data from the corn worker monitoring study - MRID 44152109) for mixer/loaders using closed systems and ground applicators using enclosed cabs were used in the occupational handler exposure/risk assessment calculations presented in Table 8. These scenarios have also been assessed using the standard PHED V1.1 unit exposure values.

Turf Uses:

MRID 430165-06: Rosenheck, L.; Phillips, J.; Selman, F. (1993) Worker Mixer/Loader and Applicator Exposure to Atrazine: Lab Project Number: AE/91/511: 126/91. Unpublished study prepared by Pan-Agricultural Labs, Inc. 309 p.

This study was submitted by the registrant to support the re-registration of atrazine for use on turf. This study focused on mixer/loader and applicator exposures from two formulations – a 90 percent active ingredient water-dispersible granule formulation applied as a spray and a 1.7 percent active ingredient granular formulation (fertilizer combination). Four different scenarios were characterized in the study: 1) Home use push-type cyclone spreader lawn treatment, 2) Home use “hand cyclone spreader” lawn treatment, 3) LCO mixing/loading and “handgun” spray application to client lawns, and 4) Golf course caretaker mixing/loading and “handgun” spray application. The study was conducted at three different sites, with each scenario represented.

Dermal exposure was monitored by using 100 percent cotton long underwear as whole body dosimeters, worn underneath work clothing. Exposure to hands, face, and neck was estimated by hand washes and face/neck swipes. Inhalation exposure was monitored using personal air-sampling pumps attached to glass fiber filters. Controls and two fortification samples were run concurrently with each set of field samples. Field recovery levels ranged between 61.5 percent to 98.2 percent.

The study met the criteria of most of the Subdivision U guidelines. The only deviation from these guidelines was that the study used an application rate slightly lower than the current maximum label rate.

Although this study is chemical-specific to atrazine, it was originally submitted under the data call-in which provided much of the data for the PHED. Therefore, this study data has been used for risk assessments for other pesticide active ingredients which had lawn-care handgun, push-spreader, or belly grinder application methods. Subsequent Outdoor Residential Exposure Task Force (ORETF) studies, described below, contained more replicates for each type of handler exposure scenario, but the belly grinder was not included. This study also monitored the exposure of mixer/loaders for spraying separately from the applicators, while commercial lawn care operators (LCOs) commonly mix, load and apply pesticides. Therefore, the only way to estimate combined exposure using this study would be addition of the individual exposures, which may be an overestimation. For the lawn hand-gun spray, the unit exposures derived from the data in this study are similar to the data in the ORETF surrogate exposure study (OMA002). The push-spreader unit exposures in the atrazine study are several times higher than those in the ORETF study OMA001, for the same level of protective clothing. The atrazine study had fewer replicates (15 vs. 40) and handled less ai (approx. 1 lb vs. 3 lb) than the ORETF study, so extrapolation may account for some of the magnitude of the difference (assuming that the more material handled, the lower the exposure/lb handled as some of the material falls or rubs off).

The ORETF also submitted exposure studies to the Agency for either occupational or non-occupational residential applicator exposure under MRID 449722-01. Those studies include application of granular formulations by push-spreader (OMA001), professional lawn care operators using truck-mounted hoses with hand-gun controlled spray (OMA002), resident-applicator using a granular push spreader (OMA003), and resident-applicator using a hose-end spray (OMA004).

Surrogate chemicals were chosen by the Task Force for their representativeness based on physical chemical properties and other factors. Dacthal, which was the surrogate chemical used for the granular spreader and low-pressure hand gun sprayer studies, has a molecular weight of 331.97 and a vapor pressure of 1.6×10^{-6} , and is believed to be an appropriate surrogate for atrazine. These studies have been reviewed by Health Canada and the Agency and found to have acceptable surrogate data for these scenarios.

Other Studies submitted but not used for calculated exposure/risks in this document:

MRID 441521-06. *An Updated Assessment of Worker Exposure for Atrazine in Response to the U.S. Environmental Protection Agency Issuance of the “Triazine Herbicides Position Document 1. Initiation of Special Review.”*

Supplement to ABR-95038: Assessment of Worker Exposure for Atrazine in Response to the U.S. Environmental Protection Agency Issuance of the “Triazine Herbicides Position Document – Initiation of Special Review” (MRID 435986-38). Laboratory Project Number: ABR-96071. Unpublished study by Ciba Crop Protection.[now Syngenta] 124 pages.

This submission by Ciba-Geigy Corporation estimates annual dose, average (amortized) daily doses (ADD), and lifetime average daily doses (LADD) for atrazine mixer-loaders and applicators. The estimates were based on dermal absorption values from human studies, use information from proprietary data bases (e.g., Maritz Marketing Research, Doane Marketing Research) and the 1987 Census of Agriculture, and dermal and inhalation unit exposure data from the Pesticide Handlers Exposure Database (PHED, version 1.1).

This submission essentially duplicates many of the occupational and residential assessments contained within this occupational and residential exposure assessment chapter. It is not evaluated further as it is based on information that is not current.

MRID 439344-15. *Preliminary Risk Characterization for Atrazine and Simazine.* Sielken, R., R. Bretzlaff, and C. Valez-Flores. (1996). Lab Project Number: 56. Unpublished study prepared by Sielken, Inc. 1254 pages.

This non-guideline submission was in response to EPA’s Position Document 1 (PD1) announcing the initiation of Special Review of the triazines herbicides atrazine, simazine, and cyanazine. The purpose of the study was to use simulated probability distributions to characterize exposure from the two triazines arising from water, diet, and occupational sources. Distributions on the lifetime average daily dose (LADD) from these sources were developed and were presented in a margin-of-exposure assessment as a percent of the reference dose (RfD – reported as 0.005 mg/kg/day). The remainder of this summary focuses on the atrazine occupational handler exposure assessment and does not consider the extensive drinking water, dietary exposure or combined exposure pathway assessments, nor does it consider any of the simazine assessments.

The assessment was crop specific and various sub-populations based on vegetation management, commercial sod production, residential lawn care (both commercial and homeowner) were examined. The worker atrazine exposure assessments were conducted for all combinations of the following:

- Growers and commercial handlers;
- Mixer/loaders, applicators, and mixer/loader/applicators;
- Aerial and ground application methods; and
- Two formulations – emulsifiable concentrates and water dispersible granules.

The surrogate exposure assessment utilized registrant supplied atrazine usage data and exposure data from the Pesticide Handlers Exposure Database. A major departure was made from the assessments typically conducted by the Health Effects Division in that distributional unit exposures were developed from PHED data based on ten body parts. Monte Carlo simulation techniques were used to combine all of the variables in the pesticide handling exposure equations.

These analyses reportedly indicate that the percent of the RfD corresponding to the estimated LADD is almost always less than 10 percent and frequently much less than 10 percent. The 50th percentile of all of these distributions are reported to be less than approximately 0.1 percent.

MRID 441521-08. *Supplemental Data and Evaluation of Exposure to Lawn Care Operators Using Atrazine in the Southern United States.* Selman, F.B. (1996). Supplement to ABR-95038: Assessment of Worker Exposure from Atrazine in Response to the U.S. Environmental Protection Agency Issuance of the “Triazine Herbicides Position Document – Initiation of Special Review” (MRID 435986-38). Laboratory Project Number: ABR-96069. Unpublished study by Ciba Crop Protection [now Syngenta]. 13 pages.

This submission was in response to the Agency's Position Document 1 (PD1) announcing the initiation of Special Review of the triazines herbicides atrazine, simazine, and cyanazine. The submission focused on the risks to Lawn Care Operators from the use of atrazine on residential lawns. This submission is not reviewed further as it is a partial duplication of the residential exposure assessment contained in this chapter and is based on outdated use information.

MRID 445976-04. *Comparison of Exposure Assessments to Atrazine and Simazine for Commercial Operators and Farmers who Mix, Load, and/or Apply Atrazine.* Selman, F.B. (1998). Novartis Laboratory Number 542-98. ABR-98068. Unpublished study prepared by Novartis [now Syngenta]. 16 pages.

This submission was in response to The Agency's Position Document 1 (PD1) announcing the initiation of Special Review of the triazines herbicides atrazine, simazine, and cyanazine. This submittal attempts to establish the equivalence of the methodologies used to calculate the exposure assessments for atrazine and simazine. This submission is not reviewed further as it is a partial duplication of the occupational exposure assessment contained in this chapter and is based on outdated use information. However, it should be noted that this submission indicates that the worker exposure assessment based on the Pesticide Handlers Exposure Database (PHED version 1.1) and a large scale monitoring study of atrazine exposure conducted during normal agricultural practices yield exposure estimates within one-half order of magnitude for all work functions.

Pesticide Handler Exposure Database

In this assessment potential agricultural worker exposures to atrazine were calculated using surrogate values from the *Pesticide Handlers Exposure Database (V 1.1)* (PHED) and for **two** major agricultural handler scenarios the potential exposure was also estimated using PHED values enhanced with Novartis [now Syngenta]- submitted worker exposure monitoring data. The Agency uses PHED as a primary source of surrogate exposure data because the data contained in the system have undergone an extensive quality control/quality assurance review process as has the system itself (i.e., values calculated using PHED can be considered reliable based on the data included in the system).

PHED was designed by a task force consisting of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide Regulation, and member companies of the American Crop Protection Association. PHED is a generic database containing measured exposure data for workers involved in the handling or application of pesticides in the field (i.e., currently contains data for over 2000 monitored exposure events). The basic assumption underlying the system is that exposure to pesticide handlers can be calculated using the monitored data as exposure is primarily a function of the physical parameters of the handling and application process (e.g., packaging type, application method, and clothing scenario). PHED also contains algorithms that allow the user to complete surrogate task-based exposure assessments beginning with one of the four main data files contained in the system (i.e., mixer/loader, applicator, flagger, and mixer/loader/applicator).

Users can select data from each major PHED file and construct exposure scenarios that are representative of the use of the chemical. However, to add consistency to the risk assessment process, the Agency, in conjunction with the PHED task force has evaluated all data within the system and developed a surrogate exposure table that contains a series of standard unit exposure

values for various occupational exposure scenarios (*PHED Surrogate Exposure Guide of August, 1998*). These standard unit exposure values are the basis for this assessment. The standard exposure values (i.e., the unit exposure values included in the exposure and risk assessment tables) are based on the “best fit” values calculated by PHED. PHED calculates “best fit” exposure values by assessing the distributions of exposures for each body part included in datasets selected for the assessment (e.g., chest or forearm) and then calculates a composite exposure value representing the entire body. PHED categorizes distributions as normal, lognormal, or in an “other” category. Generally, most data contained in PHED are lognormally distributed or fall into the PHED “other” distribution category. If the distribution is lognormal, the geometric mean for the distribution is used in the calculation of the “best fit” exposure value. If the data are an “other” distribution, the median value of the dataset is used in the calculation of the “best fit” exposure value. As a result, the surrogate unit exposure values that serve as the basis for this assessment generally range from the geometric mean to the median of the selected dataset.

Table 3 summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. These caveats include the source of the data and an assessment of the overall quality of the data. The assessment of data quality is based on the number of observations and the available quality control data. The quality control data are based on a grading criteria established by the PHED task force.

Assumptions

The following assumptions and factors were used in order to complete this exposure assessment (references follow the text portion of this document):

- The average body weight of an adult handler was assumed to be 70 kg when the toxicity endpoint is not sex specific (i.e., the short-term endpoint). A 60 kg body weight was used in assessments involving developmental studies (i.e., the intermediate-term endpoint).
- Exposure Factors: The ratio of the body surface area used in dermal calculations to the body weight to estimate potential dose overestimates by a factor of 1.1. The ratio is not physiologically matched in that the surface area is for an average male while the body weight is the median for both male/female. The reduction factor would increase a dermal MOE from 8 to 9 or 90 to 100. HED has agreed to use the NAFTA recommended values for breathing rate rather than the existing rate in Series 875 Group A (i.e., previously known as Subdivision U). Series 875 Group A recommends an inhalation rate of 29 L/min. The new NAFTA recommended inhalation rates are 8.3, 16.7, and 26.7 L/min for sedentary activities (e.g., driving a tractor), light activities (e.g., flaggers and mixer/loaders < 50 lb containers), and moderate activities (e.g., loading > 50 lb containers, handheld equipment in hilly conditions), respectively. These inhalation reduction factors are 3.5 for tractor drivers, 1.7 for mixer/loaders and flaggers, and 1.1 for handheld equipment. These changes in exposure factors will be programmed into PHED V2.0 and are characterized here for regulatory risk management decisions.

- Average work day interval represents an 8 hour workday (e.g., the acres treated or volume of spray solution prepared in a typical day).
- Daily acres and volumes (as appropriate) to be treated in each scenario include the following typical to high-end estimates:
 - 1,200 acres as the high-end estimate for aerial application to crops designated as “high acreage” (i.e, corn, sorghum, fallow lands, and conservation reserve program grasslands); applicable to short-term exposure only;
 - 350 acres as the high-end estimate for aerial application to sod farms and as a rangefinder estimate for forestry, corn, sorghum, conifer forests, fallow lands and conservation reserve program grasslands);
 - 450 acres as the estimated 75th percentile of the registrant-submitted study data of corn/sorghum handler daily acreage for ground application;
 - 200 acres for median estimate for groundboom applications to high acreage crop;
 - 80 acres for ground (spray and granular) applications to non-high acreage crops (i.e., sod farms, Christmas tree farms, macadamia nuts, guava, sugarcane);
 - 40 acres for ground (spray, rights-of-way, and granular) applications to golf courses, roadsides, and Bermuda grass highway rights-of-way;
 - 350 acres per day for flagging to support aerial spray applications;
 - a maximum of 960 tons per day of dry bulk fertilizer mixed and loaded per day with special closed system equipment. The information submitted by Syngenta support lowering the high-end estimate to 500 tons per day based on efficiency and probability of use (both are presented);
 - an estimated range of 160 (private/single farm) to 320 (commercial operator) acres treated per day with dry bulk fertilizer impregnated with atrazine using ground equipment. The acreage covered is dependant on practical limitations based on the pounds applied per acre, transit time, equipment load (10 to 20 tons per truck), and application speed (based on conditions in the field; the higher rate assumes truck application only, and lower acreage for tractor-pulled spreaders);
 - mixer/loaders for LCO applicators for lawn treatments with hose-end spray guns were estimated to support 20 trucks, with each LCO spraying an estimated 5 acres per day, based on ORETF and industry information.

- Calculations are completed at the maximum application rates for specific crops as stated on available atrazine labels. The acreage treated and quantities handled were confirmed by the data submitted in several agricultural handler studies. As noted above, some of the acreage cited in the studies were significantly higher than the Agency's estimate of a daily upper-bound limit, so the 75th percentile of those higher acreage was also included in relevant scenarios, in an effort to create as realistic exposure estimates as possible. Pesticide usage data were provided by the registrant concerning the actual "typical" application rates that are commonly used for atrazine at the SMART meeting in 5/99, and the Biological and Economic Analysis Division (BEAD) generated a Quantitative Usage Analysis (QUA, 5/10/99). Typical or average rate were well correlated between these two primary sources for major crops and were included in the exposure and risk estimates. The average or typical rates will be useful when considering risk mitigation, where risk estimates performed at the label rate exceed the level of concern.
- Due to a lack of scenario-specific data, HED sometimes calculates unit exposure values using generic protection factors (PF) that are applied to represent various risk mitigation options, such as the use of personal protective equipment (PPE) and engineering controls). PPE protection factors include those representing a double layer of clothing (50 percent PF), chemical resistant gloves (90 percent PF) and respiratory protection (80 percent PF) for use of dust/mist mask or a 90 percent PF for use of an organic vapor removing mask. Engineering controls are generally assigned a PF of 80 to 98 %, depending on the scenario of concern. For example, engineering controls for loading dry formulations assumed a closed loading system would provide a 98% PF.

Certain atrazine labels contain instructions for impregnating or coating dry bulk granular fertilizer with atrazine for application to corn or sorghum. Information obtained from the fertilizer industry was provided to the HED from the registrant, and confirmed by BEAD authorities. This information confirms that for commercially prepared dry bulk fertilizer impregnated with atrazine there is a division of labor, in that most commercial dealers, even small dealer operations, usually have different individuals running the mixing equipment and applying the mix to fields. This is because of the different skill requirements and for the sake of productivity. In the mid-western U.S., nearly all treated bulk fertilizer is produced and applied by custom commercial operations. The typical method of application to the large, mostly flat mid-western farm is via trucks with spinning disk spreaders mounted behind the vehicle. Therefore, engineering controls in the form of closed bulk loading and application systems and a closed cab truck for application are typical for the dry bulk fertilizer industry. Thus for commercial liquid or dry bulk fertilizer preparation, HED performed separate assessments for mixer/loaders, and applicators (drivers). On-farm open admixture of liquid atrazine with fertilizer, or application of treated fertilizer, is assumed to be similar to exposure scenarios in the PHED database.

HED's preliminary review of workers' exposure while impregnating dry bulk fertilizer with liquid formulations of atrazine expressed concern over an absence of data and the potential for significant exposure. According to the atrazine labels, the amount of fertilizer applied per acre to corn and sorghum ranges from 200 to 700 pounds. The maximum application rate for atrazine is 2 pounds active ingredient per acre. According to information provided to the Agency, in commercial

settings the herbicide is metered from a mini-bulk tank (several hundred gallons) to a mixing drum via a closed mechanical transfer system. The herbicide is sprayed onto the fertilizer, which is stirred by an auger that lifts it to the top of the drum. Up to 120 tons of fertilizer can be processed per hour. If the Agency assumes the tower functions for 8 hours per day, then 960 tons of fertilizer could be processed per 8-hour day. Information submitted by the registrant, obtained from custom fertilizer suppliers and other sources, indicates that atrazine is mixed with fertilizer on an as-needed basis, less than 8 hours per day, with maximum daily production no more than 500 tons per day of treated fertilizer. Information provided to the Agency indicates that typically 400 pounds of fertilizer (range 200-700 lbs) is applied per acre to corn and sorghum.

- If two pounds atrazine active ingredient per acre is impregnated onto 400 pounds of fertilizer (for the 400 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 10 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 400 pounds of fertilizer per acre rate is $(960)(10) = 9600$ pounds of atrazine active ingredient handled per day. Using the registrant-supplied upper limit of production, only 500 tons are produced, so $(500)(10) = 5000$ pounds of atrazine handled per day.

The transfer of the treated fertilizer in each instance is nearly dust-free, as it has been moistened by the herbicide. HED also has concerns that the data in PHED may not adequately represent this scenario. This is not a typical usage under usual agricultural field conditions. The amount of atrazine necessary to impregnate the tons of fertilizer that can be processed in a day is far too large to be handled by opening individual bottles or containers (as data collected for PHED), and probably involves transfer from large bulk containers. Based on this information, the Agency estimated exposure to commercial handlers engaged in impregnating atrazine onto dry bulk fertilizer using mean dermal and inhalation unit exposure data from a study of a commercial seed treatment plant using Helix™. The Helix™ data was determined to more closely resemble the enclosed bulk mixing/loading and treating fertilizer with liquids in a large commercial system. The Helix™ study data were peer-reviewed jointly by Canadian Pest Management Regulatory Agency (PMRA) / US EPA scientists in a separate document.⁹

The Agency made assumptions in performing this assessment and acknowledges that many of the assumptions were deliberately intended toward performing an upper-end assessment. One of the most conservative of these assumptions was that the mixing tower would run at full capacity for 8 hours a day. Surveys of several fertilizer admixture operators by Syngenta, submitted during the 60-day comment period, suggest that it is unlikely the plant would mix atrazine with fertilizer continuously for 8 hours. The impregnated fertilizer market is likely to be a custom operation, in that (1) the blending occurs on an as needed/as ordered basis, and (2) only the amount ordered is prepared. It is estimated that 960 tons of atrazine-impregnated fertilizer could be produced in an 8-hour day. However, based on information supplied by Syngenta, and independently confirmed by EPA specialists, 500 tons per day would be more likely, as atrazine admixture prolongs the processing time. This would provide enough fertilizer to fill 50 10-ton or 25 20-ton trucks.

According to information provided to the Agency, after impregnation, the treated fertilizer is gravity-fed through a hopper onto a conveyor belt leading to an truck, which carries it to the field. In most cases, if the fields are fairly flat and driveable, the truck will apply the treated mix to the field. Alternatively, the truck can auger the treated fertilizer onto an applicator vehicle, such as a

tractor with pull-behind spreader with a rotary spinner or a boom with numerous outlets. It is assumed that a single applicator could apply to 320 acres per day at this rate. Assuming the 10- or 20-ton truck driving 10-15 mph on a field, the truck can cover 80 acres in an hour, and 320 acres per day with travel and loading time. (A 10-ton truck covering 80 acres would only apply about 200 lbs fertilizer per acre, while the 20-ton truck could apply twice as much, but both are limited to 2 lbs atrazine/acre.) Such an exposure is similar to the ground application of granular pesticides, for which surrogate data are available. However, such an exposure surrogate is less appropriate for transferring the treated dry bulk fertilizer from the auger truck to the application equipment. *There are no data or reasonable surrogates available for the transfer operation.* Applicator risk estimates for dry fertilizer are based on data from closed cab exposure study replicates.

Bulk liquid fertilizer can also be applied to fields, and it is possible some farmers may add atrazine on site. An open mixing, loading and application scenario were therefore added to consider exposure to the private handler. The PHED data were used to estimate open mixing/loading of liquid atrazine and application of the treated liquid fertilizer separately, as there is limited data for mixing/loading and application by a single person. For on-farm liquid fertilizer treatment, using available information, it was assumed a farmer/handler could mix and load or apply enough for 160 acres per day. This is more than the standard acreage for groundboom, but less than the area that can be covered by truck. It is also similar to the average acreage per farm growing corn in the Mid-West.

HED does not have any bulk transfer/loading data. This type of exposure data may be necessary for refining this assessment, and a possible option for Syngenta would be to supply data per guideline numbers 875.2400 (dermal exposure) and 875.2500 (inhalation exposure) for mixer/loaders.

Handler Exposure and Risk Estimate Methodology

Durations of exposure are anticipated to be short-term (1-30 days) and intermediate-term (one to several months) for occupational assessments and short-term only for residential handler assessments. Data submitted by the registrants suggest most agricultural workers handle atrazine (mix, load or apply) less than 30 days per year, although the exact percentage of the worker population is unknown.

The short-term endpoints for dermal and inhalation exposures to atrazine, although based on separate studies, have a common endpoint effect, and therefore, can be combined. The intermediate-term dermal and inhalation endpoints have the same adverse effect, and therefore, the intermediate-term risks are combined. Each endpoint was chosen because it was the lowest-dose effect for that route and duration of exposure. Where a developmental endpoint was chosen, the mean female body weight (60 kg) is applicable, and exposure risk estimates are considered protective of the entire (both genders) working population. A correction factor for difference in body surface area between males and females is being developed; until then the risk estimates based on the developmental endpoint are considered slightly more conservative (overestimated) for males.

Handler exposure assessments are completed using a baseline exposure scenario and, if required, increasing levels of risk mitigation (PPE and engineering controls) to achieve an

appropriate margin of exposure. Tables 5-7 present exposure and risk assessment calculations for the handling of atrazine. The daily exposures are used to complete the dermal and inhalation risk assessments for short and intermediate-term exposure scenarios. The baseline scenario generally represents a handler wearing long pants, a long-sleeved shirt, and no chemical-resistant gloves. Table 5 presents the dermal and inhalation exposures to atrazine at baseline. Table 6 presents the exposure/risk calculations with PPE mitigation, and Table 7 presents the exposure/risk calculations when handlers employ engineering controls mitigation.

Potential daily exposures were calculated using the following formulae:

$$\text{Daily Dermal Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) = \text{Unit Exposure} \left(\frac{\text{mg ai}}{\text{lb ai}} \right) \times \text{Use Rate} \left(\frac{\text{lb ai}}{\text{A}} \right) \times \text{Daily Acres Treated} \left(\frac{\text{A}}{\text{day}} \right)$$

$$\begin{aligned} \text{Daily Inhalation Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) = \\ \text{Unit Exposure} \left(\frac{\mu\text{g ai}}{\text{lb ai}} \right) \times \text{Conversion Factor} \left(\frac{1\text{mg}}{1,000 \mu\text{g}} \right) \times \text{Use Rate} \left(\frac{\text{lb ai}}{\text{A}} \right) \times \text{Daily Acres Treated} \left(\frac{\text{A}}{\text{day}} \right) \end{aligned}$$

Inhalation and dermal doses were calculated using the following formulae:

$$\text{Daily Inhalation Dose} \left(\frac{\text{mg ai}}{\text{kg/day}} \right) = \text{Daily Inhalation Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) \times \left(\frac{\text{Inhalation Absorption Factor} \left(\frac{\text{percent}}{100} \right)}{\text{body weight (kg)}} \right)$$

where: inhalation absorption factor is assumed to be 100 percent for both short- and intermediate term doses

$$\text{Daily Dermal Dose} \left(\frac{\text{mg ai}}{\text{kg/day}} \right) = \text{Daily Dermal Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) \times \left(\frac{\text{Dermal Absorption Factor} \left(\frac{\text{percent}}{100} \right)}{\text{body weight (kg)}} \right)$$

where: dermal absorption is assumed to be 6 percent or 0.06 for the intermediate-term assessment and 100 percent for the short-term assessment

The dermal absorption factor of six percent was applied to the intermediate term exposure estimates. The short term exposure assessment does not require use of a dermal absorption factor since the toxicity endpoint is based on a 21 day dermal study. The short-term dermal dose was calculated using a 70 kg body weight. The short-term inhalation doses were calculated using a 60-kg body weight. Both inhalation and dermal intermediate-term doses were calculated assuming a body weight of 60 kg since the toxicity endpoints are based on a 6-month luteinizing hormone study.

The following formulae were used in the calculation of the short- and intermediate-term dermal and inhalation MOEs.

$$\text{Dermal MOE} = \frac{\text{Dermal NOAEL (mg/kg/day)}}{\text{Short-term Dermal Dose (mg/kg/day)}}$$

$$\text{Inhalation MOE} = \frac{\text{Inhalation NOAEL (mg/kg/day)}}{\text{Short-term Inhalation Dose (mg/kg/day)}}$$

Since both the short-term dermal and inhalation endpoints include the effect of decreased weight gain, the short-term doses were combined. The dermal and inhalation intermediate-term endpoints were based on a 6-month LH study, therefore doses were combined across routes. Combined MOEs for short and intermediate-term exposures were calculated using the following formula:

$$\text{Combined MOE} = \frac{1}{\frac{1}{\text{dermal MOE}} + \frac{1}{\text{inhalation MOE}}}$$

Summary of Exposure and Risk Estimates: Concerns for Handlers, Data Gaps, and Confidence Levels

Short-term Exposure Duration Risk Estimates

The baseline short- and intermediate-term handler exposure and risk estimates are shown in Table 5. The combined exposure route (dermal + inhalation) risk estimates are also summarized in Table 9. Depending on data available or controls applicable, not all scenarios could be assessed for each level of exposure control. The scenarios for label uses of liquid formulation on liquid fertilizer or liquid formulation on dry fertilizer scenarios were assessed using surrogate data from PHED and the seed treatment study, which were not specific for the method assessed. For the aerial applicators, data were available for the engineering control (closed cockpit) scenarios only.

All but five short-term handler exposure scenarios (1a and 2a: mixing/loading liquid or dry flowable for aerial application to 1200 acres of crop) estimated using PHED or ORETF data had MOEs greater than 100 when personal protective equipment was used, and these five scenarios of concern were mitigated with engineering controls (see Table 7). The most common scenarios, in terms of pounds of active ingredient used annually, are the aerial and ground spraying of corn and sorghum. Almost all of the short-term exposure scenarios which had MOEs less than 100 with baseline clothing were mixing and loading liquid formulations in open systems (for aerial, groundboom, LCO or fertilizer admixture). All methods of application (granular, spray) to lawns by LCOs, using ORETF data, had short-term MOEs greater than 100 when gloves were used. Turf and lawn applications are the leading nonagricultural use of atrazine.

Summary of PHED Short-term Risk Estimates Using PHED/ORETF Data Sets:

Baseline:

- Short-term inhalation at baseline MOE > 100 for all scenarios
- Short-term dermal risks at baseline are:
 - MOE < 100 for mixing/loading liquids for most equipment

- MOE > 100 for mixing/loading dry flowable for all equipment except highest acreage (1200 acres/day)
- MOE > 100 for loading granulars
- MOE > 100 for all applicator scenarios (except right-of-way sprayer) for which data are available
- MOE > 100 for loader/applicator scenarios of granular formulations
- MOE < 100 for mixer/loader/applicators using low pressure hand wands
- MOE > 100 for all flagger scenarios

PPE:

- MOE > 100 for mixing/loading liquids, except chemical fallow at 1200 acres/day (MOE = 96)
- MOE > 100 for mixing/loading DF/WDG except high acreage (1200 acres/day)
- Mixer/loader/applicator scenarios are not of concern with baseline attire plus gloves.
- All loader scenarios involving granular formulations, all applicators (except right-of-way and aerial applications), all loader/applicators involving granular formulations, and all flaggers supporting aerial spray applications are not of concern at baseline attire -- without additional PPE

Engineering Controls:

- All scenarios, where controls were applicable, had MOEs above 100.

The combined passive dosimetry/biomonitoring study (MRID 441521-09/11) data were used to calculate agricultural handler MOEs using mean and 90th percentile values (Table 4). In order to compare the estimated daily exposures to those calculated using PHED data, the dermal dose from passive dosimetry and the calculated internal dose from biomonitoring were adjusted for daily lbs ai handled using the same label application rate and estimated daily acres treated (2 lbs ai/acre and 200 acres/day). The 90th percentile biomonitoring values provided short-term estimated MOEs of 64-250 for the different job categories involved in mixing, loading, and applying liquid formulation by groundboom. The passive dosimetry 90th percentile data for the same handler exposure scenarios produced MOEs ranging from 37 to 114.

The biomonitoring-only study (MRID 441521-05/06) included various formulations, levels of protection (mostly closed mixing/loading and enclosed cab), quantities handled, and application rates. The study did not control for prior day's exposure to atrazine. Because approximately 12% of atrazine is excreted as chlorometabolites in the 24 hours after exposure, with repeated daily exposure it is difficult to determine the relation between amount of chemical handled and dose excreted. Therefore, no attempt was made to normalize the exposure by amount of atrazine handled. Using the 90th percentile of the data, normalized to body weight only, short-term daily MOEs greater than 100 (range 450-1600) were estimated for all mixers, loaders, applicators, and mixer/loader/applicators applying ground spray to corn. These estimates are intended for risk characterization purposes only, and are based on varying quantities of atrazine handled per day.

For quality assurance purposes, the 90th percentile atrazine mean daily dose excreted in urine for each work task (mixer/loader, applicator, mixer/loader/applicator) from both of the submitted biomonitoring studies were compared (see Table 4). This daily dose was used to determine a MOE. The MOEs from each study were compared. The finding was that the biomonitoring doses and MOEs were very similar for each task category when the mean maximum 90th percentile were compared; less than a four-fold range existed between studies (ST MOE range 280-5700; IT MOE range 330-1600). The total dose was assumed to be 99% from the dermal route and only 1% inhalation based on atrazine-specific and PHED data for each task.

The PHED and corn applicator study data (which used closed systems) were combined as in the registrant submission and had essentially the same outcome as the PHED data alone for the engineering control scenarios (these estimates are included in summary Table 8). All handler scenarios had short-term combined MOEs greater than 100.

Intermediate-term Exposure Duration

As stated previously in this document, intermediate-term exposures of a month or more are considered less common than short-term exposures for atrazine handlers, but are presented for the purpose of identifying potential risks and may be further refined as more atrazine-specific use data becomes available. When interpreting intermediate-term exposure estimates, emphasis should be placed on typical or average exposures, where such information is available to refine the estimates.

As with short-term scenarios, most of the baseline intermediate-term dermal risk estimates which had MOEs less than 100 were for mixer-loaders of liquids and dry flowable/water dispersible granules (See Table 5). High acreage crop liquid application, right-of-way spraying, hand-applied turf application, and the highest rate flagging scenario also had dermal MOEs below 100. As stated above, nearly all of the inhalation exposure risk estimates had MOEs greater than 100 without a respirator, with mixer/loaders of large quantities accounting for most of the higher risk estimates. Even with coveralls, gloves, and respirators, most of the mixer/loader dermal risk estimates for the larger crops, including corn and sorghum, remain above the level of concern (see Table 6). Only one of the intermediate-term combined route applicator risk estimates was below a MOE of 100 with maximum protective clothing: the right-of-way sprayer using the 4 lb ai/acre rate. Engineering controls raise most of the total MOEs above 100, except for mixing and loading of the largest quantities (dry flowable/WDG) of chemical handled, such as for the highest acreage and fertilizer admixture rates (see Table 7). With engineering controls, all applicator risk estimates have MOEs above 100, except where not feasible (i.e., right-of-way sprayer). Intermediate-term MOEs for LCOs were all above 100 when ORETF data were used, and chemical resistant gloves were used. The right-of-way applicator risk estimates exceed the level of concern and have no known engineering controls.

The geometric mean values of the passive dosimetry sampling from study MRID 441521-09/11 were used to estimate a central-tendency intermediate-term dose (Table 3). The estimated

mixer/loader, mixer/loader/applicator and applicator MOEs (with engineering controls for most replicates) ranged from 210-610. Intermediate-term MOEs based on the geometric mean biomonitoring data from the same study for all handlers were between 82-550 when normalized by lb ai handled, and MOEs of 330-950 were estimated by daily dose alone. The geometric mean data from the MRID 445976-05/06 study were normalized to body weight and daily MOEs of 430-1600 were estimated. Using the corn applicator study with engineering controls (Table 8), all mixing/loading or applicator scenarios had combined MOEs greater than 100.

Summary of Intermediate-term combined dermal and inhalation risks:

Baseline

- MOE < 100 for all mixer/loader scenarios for liquid formulations
- MOE < 100 for all mixer/loader scenarios for dry flowable formulations, *except* where handling a total of less than 250 lbs ai/day (for ground applications)
- MOE > 100 for loading granulars
- MOE > 100 for applying with groundboom equipment, except when the rate is 2 lb or greater AI per acre and 450 acres per day are treated
- MOE < 100 for applying spray to right-of-ways
- MOE > 100 for applying granular with ground equipment
- MOE < 100 or data unavailable for all mixer/loader/applicator scenarios except applying granulars with a push spreader
- MOE > 100 for flagging except with an application rate of 4.0 lb ai and applying to 350 acres per day (MOE = 76)

PPE

- MOE < 100 for mixer/loader scenarios involving support of aerial applications with liquid formulations, even with baseline attire plus maximum PPE at the higher application rates (i.e., 2.6 pounds active ingredient per acre and above).
- MOE > 100 for mixer/loader scenarios involving support of aerial applications with liquid formulations with baseline attire plus PPE (ranging from gloves to gloves plus double layers to gloves plus double layers plus respirator) at rates of 2.0 pounds active ingredient per acre and below *provided* the acres treated per day are 350 per day or less. (Information on aerial application indicates no single applicator would treat 1200 acres per day for more than 30 days).
- MOE > 100 for mixer/loader scenarios involving support of groundboom, rights-of-way, and lawn handgun applications with baseline attire plus PPE (ranging from gloves to gloves plus double layers), *except* scenarios involving application rates of 2.0 pounds or more active ingredient per acre and 450 or more acres treated per day, which have MOE < 100 even with maximum PPE of gloves plus double layers plus respirator (some MOEs for applicators are 95 at 450 acres and less than 2 lb ai/acre).
- MOE < 100 for mixer/loader scenarios involving support of aerial applications with water dispersible granule formulations even with maximum PPE, except at 1 lb ai/acre.

- MOE > 100 for mixer/loader (DF/WDG) scenarios involving support of groundboom and rights-of-way applications either with baseline attire or baseline attire plus PPE (ranging from gloves to double layers plus gloves), *except* scenarios involving 300 or more pounds of active ingredient handled per day, which have MOE < 100 even with maximum PPE of gloves plus double layers plus respirator.
- MOE > 100 for mixers/loader/applicator scenarios applying granulars with push-type spreader wearing gloves
- MOE > 100 for all applicator and mixer/loader/applicator scenarios (for which data are available) either with baseline attire or baseline attire plus PPE (ranging from gloves to gloves plus double layers to gloves plus respirator), *except* for applying with a rights-of-way sprayer, for which MOE < 100 even with maximum PPE (MOE = 37). Note that engineering controls are not available for this scenario.
- MOE > 100 for all flagger scenarios with baseline attire at lower application rates, or with baseline attire plus PPE (ranging from double layers to double layers plus respirator), at applications of 4 pounds active ingredient per acre to 350 acres per day (high-end).

Engineering Controls

- MOE > 100 for all mixer/loader scenarios involving liquid formulations with baseline attire, baseline attire plus PPE, or engineering controls, *except* scenarios involving commercial admixture of bulk fertilizer.
- MOE > 100 for all mixer/loader scenarios involving water dispersible granular formulations with baseline attire, baseline attire plus PPE, or engineering controls, except for dry flowables for conifers/turf at 4 lb ai/acre and 350 A/day (MOE = 93), and for fallow at 3 lb ai/A and 450 acres/day (MOE = 97) .
- MOE > 100 for all aerial application scenarios with enclosed cockpits.
- MOE > 100 for all other applicator scenarios with baseline attire or baseline attire plus PPE, *except* (as noted above under PPE) for applying with a sprayer to rights-of-way, which is of concern even with maximum PPE. Note that engineering controls are not available for this scenario.
- MOE > 100 for all flagger scenarios with baseline attire, baseline attire plus PPE, or engineering controls.

Data Gaps

Data gaps exist for the following scenarios:

- PHED unit exposure values are not available for using liquid formulations to impregnate liquid or dry bulk fertilizer; therefore, closed system engineering control values for mixing and loading liquids were used as a surrogate for commercial operations. For comparison, the Helix™ seed treatment study exposure data were also used, which provided slightly lower risk estimates.

- The PHED data for mixing and loading liquids and/or applying liquids or granulars were used to estimate on-farm operation exposures.
- No exposure data were available for application of treated fertilizer to soil. The driver exposure was assumed to be no greater than for a granular applicator in a closed cab (scenario 9).
- More information on days of use per year for right-of-way sprayers and fertilizer admixture would help refine the risk assessment by selection of the most appropriate exposure duration and endpoint.

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the occupational exposure risk assessment. These include:

- The most common use scenarios, agricultural field spraying, had chemical specific data submitted to support the unit exposures used. Newly submitted data from the ORETF (not chemical-specific) with higher confidence level than the PHED data sets, were used for some turf applications. However, several handler assessments (including aerial and belly-grinder) were completed using “low quality” PHED data due to the lack of a more acceptable data set.
- Regarding the dry or liquid bulk fertilizer scenarios, supplemental information was supplied by the registrant and confirmed by independent sources. The information supports the numbers used for “usual practice,” but technically feasible quantities are still shown for comparison in the risk estimates. Uncertainty exists as to whether commercial handlers of treated fertilizer would ever exceed thirty days of exposure per year, but handlers on individual farms would certainly have only short-term exposures from handling and application. There are no specific data for unit exposure from fertilizer treatment, and use of the PHED and Helix™ data as surrogates represent another uncertainty.
- Biomonitoring data were of low confidence due to a lack of creatinine measurements and/or incomplete collection, lack of a baseline excretion measure, and/or continuous seasonal exposure; and none were sampled for 72 hours after a single exposure to obtain most of the chlorometabolites. The existence of a “steady-state” of atrazine exposure was also not supported by the data submitted, given the high variability of the measured internal dose.

POSTAPPLICATION EXPOSURES AND RISK ESTIMATES

Postapplication Exposure Scenarios

Atrazine currently has an agricultural worker restricted entry interval (REI) of 12 hours postapplication, during which time entry into the treated area is prohibited except with specified personal protective equipment (PPE) unless there is no contact with treated surfaces. Most of the atrazine used in agriculture is applied to corn and sorghum early in the season, either before weeds emerge (pre-emergence) or when the crops are quite small (generally less than 12 inches high). This fact, and the degree of mechanization in cultivating these crops, minimizes the postapplication contact of workers with the chemical on these crops. However, the Agency has determined that there are potential postapplication exposures to individuals re-entering atrazine treated areas for the purpose of:

- *Corn and sorghum*: irrigating and scouting
- *Macadamia nut orchards*: mowing and scouting
- *Guava orchards*: mowing and scouting
- *Sugarcane fields*: scouting
- *Conifer (including Christmas tree) farms*: scouting
- *Sod farms*: mowing, mechanical weeding, irrigating and scouting
- *Golf-course turfgrass*: mowing, weeding, and scouting

Some data received during the comment periods have been used to refine and characterize the potential postapplication exposures to atrazine. According to use information submitted by Syngenta and verified by BEAD and HED agricultural experts, no regular reentry activities occur in conifer forests during the seedling stage, when atrazine is used, other than fertilizing. Atrazine is applied in the “dormant” months to conifer tree farms, and pruning and shaping are not done at that time. Therefore, only nominal contact activities, such as scouting or “cruising” are likely in the first months after application of atrazine to conifer farms. No hand weeding is anticipated on sod farms, and it is not common on golf courses. Therefore, only short-term high contact exposures are expected on golf courses. Harvesting sod is a high-exposure activity, but would not occur within the 30 day pre-harvest interval in Florida, and is considered “unlikely” to occur within 30 days of an application in other states, for economical reasons and because herbicides reduce the rooting-in of transplanted sod. An intermediate-term exposure to lower levels of atrazine during sod harvesting is possible. Additional data on sugarcane postapplication activities are needed, but atrazine is not applied once the crop has “closed in,” so only scouting or similar exposures are assessed.

Data Sources for Scenarios Considered

Three chemical-specific studies, one of dislodgeable foliar residue on corn, and two of transferable turf residues, were submitted in support of the reregistration of atrazine. All three studies were reviewed and found to acceptable for use in the atrazine risk assessment.

MRID 448836-01. *Dissipation of Dislodgeable Foliar Residues of Atrazine on Field Corn.* Prochaska, L.M. (1999). Stewart Agricultural Research Project Number: SARS-97-54; Wildlife International Project Number: 468C-105. Unpublished study prepared by Stewart Agricultural Research Services. 131 pages.

This dislodgeable foliar residue (DFR) study was submitted by Sipcam Agro USA, Inc. (formerly Sostram Corporation), in support of atrazine re-registration requirements. The study was conducted at one test

plot located in Shelby County, Missouri. Atrazine was applied once to field corn in two different formulations, Atrazine 4L and Atrazine 90DF. Atrazine 4L is a liquid suspension concentrate containing 4.0 lbs ai/gallon and Atrazine 90DF is a water dispersible granules containing 90 percent active ingredient. The formulations were applied using CO₂-pressurized backpack sprayers equipped with flat fan nozzles. Application volume was 20 gallons per acre. Atrazine 4L was applied at a rate of 2 lbs ai/A and Atrazine 90DF was applied at a rate of 2.5 lbs ai/A. Labels indicate that the maximum application rate was 2.5 lbs ai/A per calendar year and the minimum spray volume was 10 gallons per acre. Corn was 12 inches high when the study began. Samples were collected at 4 hours, 12 hours, 1 day, 2 days, 3 days, 5 days and 7 days after application.

Concurrent fortified laboratory recovery samples and two sets of field-fortified samples showed good recoveries and indicated that there was no appreciable loss of atrazine during shipping and sample storage. The study met most criteria identified in OPPTS Test Guideline Series 875.2100, Foliar Dislodgeable Residue Dissipation: Agricultural. Significant deviations from this guideline were:

- The study was conducted at only one location, instead of at three locations as specified in the guideline.
- The target application rate for both formulations was 2.5 lb ai/A, which was the maximum annual application rate. However, the Atrazine 4L formulation was applied at 2.0 lb ai/A due to a calculation error.
- The spray volume was twice the minimum application volume specified on product labels. Under the guidelines, application should be made using the least dilution and highest label permitted rate.
- Although samples of the spray solution were collected at the time of application, these samples were not analyzed by the analytical laboratory. It could not be determined if the target application rate was attained.

The highest mean atrazine residues occurred at 4 hours after application for both the Atrazine 90DF (4.21 µg/cm²) and Atrazine 4L (2.64 µg/cm²) formulations. Other residue values are shown in Table 10.

The uncorrected dislodgeable foliar residue data from Day 0 through Day 7 data were averaged, natural log (ln) transformed and analyzed assuming first-order dissipation kinetics using simple linear regression. Calculated atrazine dissipation half-lives were 1.56 days (R²=0.95) for Atrazine 4L and 1.2 days (R²=0.87) for Atrazine 90DF.

MRID 449580-01. *Determination of Transferable Residues on Turf Treated with Atrazine.* Hofen, J. (1999). Stewart Project Number: SARS-98-81. Ricerca Project Number: 7617-98-0197-CR Unpublished study prepared by Stewart Agricultural Research Services, Inc. and Ricerca, Inc. 358 pages.

This study on turf-transferable residues (TTR) was submitted by Sipcam Agro USA, Inc. in support of atrazine reregistration requirements. The dry-flowable formulation (Atrazine® 90DF) was applied to Bermuda grass turf in Georgia (using a backpack sprayer) and North Carolina (using a tractor mounted sprayer). The study quantified turf-transferable atrazine residues collected on cloth sheeting.

Overall, the study met most guideline criteria of the Environmental Protection Agency's (US-EPA) OPPTS Series 875.2100, Transferable Residue Dissipation: Lawn and Turf. The most important deviations were:

- Only two geographically distinct test sites were included in this study.
- Only one application was made in this study while the label permits a second application to turf.
- No tank mix samples were collected and analyzed.

Atrazine® 90DF was applied once at an application rate of 0.72 ounces active ingredient (ai) per 1,000 square feet (±5%). This rate was the maximum label rate. Table 10 shows the measured atrazine levels for the Georgia and North Carolina study sites. Pre-trial residues at both sites were all less than the detection level of 0.00090 µg/cm². Levels remained below the detection levels at the control plots for both sites throughout the study. Turf-transferable atrazine levels did not dissipate rapidly. At both test sites, atrazine transferable residues increased up to 12 hours after application and then decreased from 12 hours after application through 21 days after treatment. In North Carolina, the average day-of-application transferable residue was 1.32 µg/cm²,

decreased by ten-fold in the first 24 hours, increased slightly during the first week, then declined slowly thereafter. In Georgia, the average residue level was $0.24 \mu\text{g}/\text{cm}^2$ after application and declined to $0.14 \mu\text{g}/\text{cm}^2$ on day 21. This value was substantially higher than the value of $0.030 \mu\text{g}/\text{cm}^2$ attained at day 14. The increased residues transferred on days 3 and 21 after treatment were attributed to increased moisture, either dew or precipitation, causing higher rate of transfer to the cloth. The longer-lived residues in Georgia may have been related to the lower than normal precipitation (only 0.17 inch, or 7% of normal for that period). Both laboratory recoveries and field fortifications were satisfactory, although the field fortifications were run at levels which were outside the range of the TTR samples.

Natural log (ln) transformed data were analyzed using linear regression assuming pseudo-first order dissipation kinetics. Turf-transferable residue data were not corrected for field or laboratory recovery. Because the first regression analysis of all data yielded low correlation coefficients at both study sites, an additional analysis was performed omitting day 3 and day 21 residue data from Georgia and 12 hour residue data from North Carolina. The calculated atrazine half-lives for the first regression (all data) were 17.1 days for Georgia ($R^2=0.18$) and 3.2 days for North Carolina ($R^2=0.81$). For the second regression, the calculated atrazine half-lives for Georgia and North Carolina were 5.2 days ($R^2=0.89$) and 3.8 days ($R^2=0.88$), respectively.

MRID 449588-01. *Determination of Transferable Turf Residues on Turf Treated with Atrazine Applied in a Granular Fertilizer Formulation.* Rosenheck, L. (1999). Novartis Laboratory Number 805-98. ABC Laboratory Number 45035. Unpublished Study prepared by Novartis [now Syngenta]. 183 pages.

This study on turf-transferable residues (TTR) was submitted by Novartis Crop Protection, Inc. in response to an occupational/residential exposure Data Call-In, and in support of atrazine re-registration requirements. Scott's Bonus S Weed and Feed®, a granular fertilizer product containing 1.1 percent atrazine, was applied to turf in Georgia and Florida, and the effect of subsequent irrigation on residue levels was examined. The study quantified turf-transferable atrazine residues collected on cloth sheeting. Scott's Bonus S Weed and Feed® was applied once to irrigated and non-irrigated turf test-plots in Georgia and Florida at a target application rate of 2.0 lbs active ingredient per acre. Turf-transferable atrazine residue samples were collected at intervals up to 35 days after treatment.

Overall, the study met most criteria of the OPPTS Post-application Exposure Monitoring Test Guidelines, 875.2100, Transferable Residue Dissipation: Lawn and Turf. The most significant deviations were:

- Only two distinct test sites were included in this study, rather than the three required by the guidelines.
- Only one application was made in this study although the product label permits a second application to turf.
- No control test-plots were designated, therefore no control samples were collected. Pre-application "control" samples were mostly negative for atrazine, except for four collected from the watered-in test plot in Florida. These levels were just at, or above, the Minimum Quantifiable Limit (MQL) of 5 $\mu\text{g}/\text{sample}$.

The highest average turf-transferable residue ($0.2160 \mu\text{g per cm}^2$) occurred in the Florida non-irrigated test plot at 4 hours. On Day 1, the average turf-transferable residues were $0.0077 \mu\text{g per cm}^2$ (irrigated) and $0.0883 \mu\text{g per cm}^2$ (non-irrigated) at the Florida test site and $0.0097 \mu\text{g per cm}^2$ (irrigated) and $0.0351 \mu\text{g per cm}^2$ (non-irrigated) at the Georgia test site. See Table 10.

The turf transferable atrazine residue data were corrected using an average field-fortified recovery value of 89.9 percent (an average value from field fortified sample results for two fortification levels at both test sites). The corrected data from day 0 to day 35 were averaged, natural log (ln) transformed, analyzed using simple linear regression assuming pseudo-first order dissipation kinetics. Calculated dissipation half-lives for Georgia were 6.9 days ($R^2=0.91$) and 8.9 days ($R^2=0.46$) for non-irrigated and irrigated test-plots, respectively. The calculated dissipation half-lives for Florida were 4.9 days ($R^2=0.93$) and 3.3 days ($R^2=0.71$), for non-irrigated and irrigated test-plots, respectively.

Assumptions Used in Postapplication Exposure Calculations

Based on data submitted for reregistration, and the Quantitative Usage Analysis (6/99) by D. Widawsky of the Biological and Economic Assessment Division, the most common postapplication exposures will occur for workers in field crops, primarily corn and sorghum, and on turf. Based on label restrictions and pattern of use, atrazine is only applied in the early part of the corn or sorghum growth cycle, when the plants are less than 12" tall. The only activities at this time would be scouting or irrigating, which have low contact potentials (transfer coefficients). Chemical-specific data is available for DFRs on corn, which can also be used as a surrogate for sorghum. Scouting and irrigating are the only common early season practices for sorghum as well, and this crop is mechanically harvested. The foliar residue data from corn are not considered appropriate to translate to conifers, owing to the great difference in leaf structure, shape, and overall plant conformation. Due to a lack of other DFR data, however, the corn residues will be used for screening-level risk assessments. Sugar cane crops are burned, then harvested mechanically, then sprayed with atrazine. Based on sugar cane cultural practice, workers will not normally enter treated fields on foot until planting, which is months after atrazine application. Up to 3 additional applications are permitted on the label, until the cane 'closes in,' and scouting or other low-contact activities may occur. Nut and guava orchards are typically sprayed by ground equipment in such a manner as to limit the amount of foliage on the tree that is sprayed, although aerial application is also possible. There should be minimal postapplication exposure to workers in those types of orchards when ground methods are used. Mowing would be a common postapplication activity after either spraying method. Treated turf or grasses will routinely require reentry activities, such as mowing and watering, and eventually harvesting in the case of sod farms. Fallow, right-of-way, and prairie might also be mowed. Therefore the studies listed above that are chemical-specific for atrazine, and the DFRs may be used in estimating postapplication exposures.

Because atrazine has a low vapor pressure (3.0×10^{-7} mm Hg) and is only used outdoors, and based on a large historical database, the inhalation component of postapplication exposure is anticipated to be negligible. Therefore, all calculations of postapplication risk estimates have been done for dermal exposure only, and there was no need to combine postapplication exposure routes for workers.

Many of the atrazine uses are for pre-emergent uses. Since atrazine is used on crops which are predominantly planted and harvested mechanically, there would usually be little postapplication exposure due to pre-emergent uses. The MOEs provided in this assessment are only for the foliar applications.

The applicability of postapplication risk assessments to working farm children (ages 12 and over) has been evaluated by the Agency. Historical transfer coefficient data indicate that the higher the productivity of a worker the higher the transfer coefficient. HED believes that it is reasonable to assume that the productivity of a 12 year old is less than that of an adult. HED believes that transfer coefficients for 12 year olds are lower than for adults and that the difference in the magnitude of the transfer coefficient will nullify the 18 percent underestimate attributed to the ratio of body surface area to body weight (internal communication, J. Dawson, EPA, 12/2000).

Exposure and Risk Calculations

Short- and intermediate-term daily absorbed doses and MOEs were calculated as follows:

$$Dose \text{ (mg/kg/d)} = \frac{(DFR \text{ (}\mu\text{g/cm}^2\text{)} \times Tc \text{ (cm}^2\text{/hr)} \times CF \left(\frac{1 \text{ mg}}{1,000 \text{ }\mu\text{g}} \right) \times Abs \times ED \text{ (hrs/day)})}{BW}$$

Where:

| | | |
|-----|---|---|
| DFR | = | daily DFR, as calculated above for the assumed average reentry day |
| Tc | = | transfer coefficient; |
| CF | = | conversion factor (i.e., 1 mg/1,000 μ g) |
| Abs | = | dermal absorption (100 percent for short-term, and 6 percent for intermediate-term) |
| ED | = | exposure duration; 8 hours worked per day |
| BW | = | body weight (70 kg for short-term and 60 kg for intermediate-term) |

Dermal MOEs were calculated as follows:

$$MOE = \frac{NOAEL \text{ (mg/kg/day)}}{Dose \text{ (mg/kg/day)}}$$

Where:

| | | |
|-------|---|--|
| NOAEL | = | 360 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term |
| Dose | = | calculated absorbed dermal dose |

For the purposes of occupational risk assessments, the following input values were chosen:

- Although the short-term endpoint is defined as adequate for activities lasting up to one month, some activities, such as mowing golf course turf may have more than 30 days exposure. Therefore the geometric mean of the first month post-application residue data, or the predicted values were used for intermediate-term risk estimates for activities on turf (formulation-specific).
- Standard values for dermal transfer coefficients were used (updated 8/2000).
- For post-application activities on crops other than turf or grasses, the highest average daily residues from the corn DFR study were used for the short-term, and the geometric mean of the

predicted 0-30 day residues were used for the intermediate term risk estimates (actual data were only collected to 7 days after treatment).

Postapplication Exposure Risk Estimates

The various potential postapplication worker exposure scenarios cited above can be bracketed using the results of the corn DFR study for reentry into corn or sorghum, and using the turf DFR studies for turf and sod reentry activities. As noted above, these are representative exposures, and it is considered unlikely that higher exposures than those calculated for these crops will occur. The corn DFR data were applied to other crops, such as sugarcane and tree farms, for screening purposes, but the resulting MOEs are considered highly conservative based on the entry practices cited in the previous section.

The ARTF transfer coefficients were applied wherever possible. The reentry MOEs for corn and sorghum ranged from a minimum of 660 for short-term to a minimum of 350,000 for intermediate-term risk estimates (see Table 10). Scouting activities in sugarcane had an estimated short-term MOE of 68 and an intermediate-term MOE of 35,000 (assuming full foliage but prior to closing-in of the cane). High-contact activities in tree farms, such as pruning and harvesting, are unlikely to occur within 30 days (estimated residue dissipation time) after application, which occurs in the dormant season. Scouting conifer forests had estimated MOEs ranging from 140 to 710,000 for short- to intermediate-term exposures, using the adjusted corn DFR data.

The highest average postapplication TTRs were used from each study, due to the variability of data, which was well characterized by the study authors as reflecting the presence of moisture (which increased residue transfer) or the lack of precipitation, which prolonged dissipation. The TTRs were found to be between about 0.5-1% of the application rate for granular and 1-6% for spray treatments, which agrees well with TTR studies of other pesticides. Therefore, the residues were not averaged, and the actual data is believed to represent realistic ranges of TTRs for different conditions. For turf or sod mowing, a transfer coefficient of 500 cm²/hr was used, based on the ARTF study data (see HED Exposure SAC Policy guidance 3.1, 8/00).

Short-term exposure from mowing treated turf had an estimated MOE range from 1400-7500, using the highest average first day-after-treatment (12 hour) TTR data from the spray application (see Table 9 for TTR data, Table 11 for granular TTR and MOEs and Table 12 for liquid TTR data and MOE calculations). Using the granular application study's highest average TTR data, short-term MOEs ranged from 8400 to 25,000 for mowing turf and sod. For the highest contact maintenance activities on turf grass (considered short-term), using the granular TTR data yielded a MOE of 250 (non-irrigated) to 750 (irrigated) and liquid TTR data produced MOEs of 230-250 (based on dry residue since transplantation is not conducted after application as atrazine is applied to dormant turf or after harvest; however, mowing may be conducted at any time). All other activity short-term MOEs translated from the turf TTR data had MOEs lying between 250 and 25,000 (transplanting sod vs. mowing/scouting roadsides). The intermediate-term MOEs for all turf and sod mowing scenarios, using one month average residues, were greater than 840, the lowest being from the liquid application in Georgia.

Summary of Postapplication Risk Concerns, Data Gaps, and Confidence in Exposure and Risk Estimates

Using the highest average daily foliar residues from each study at day 0-1 for short-term and the geometric mean of 30 days after treatment for intermediate-term, all but one postapplication dermal risk estimates for all scenarios were below the HED's level of concern. The lowest MOE, scouting sugarcane (68), was assessed shortly after application and used transfer coefficients and residue levels which were combined to make a high-end or conservative exposure estimate.

There are no chemical-specific or suitable surrogate residue data for conifers, and therefore the postapplication worker exposure to conifers treated with atrazine cannot be assessed accurately. However, the patterns of application (aerial and ground-spray), generally target the pest species rather than the tree crop. In Christmas tree farms, there is infrequent entry into the forest, workers wear long sleeves for protection, and therefore postapplication exposure is very limited. Risk estimates are based on chemical-specific studies which are believed to be reasonable surrogates for both corn and sorghum postapplication exposure.

NON-OCCUPATIONAL EXPOSURES AND RISK ESTIMATES

Atrazine is labeled for consumer use to control weeds in lawns, and for professional application to recreational turf and lawns. Residents or consumers applying atrazine products to their lawns may be exposed through skin contact or by inhalation. Postapplication dermal exposure for adults and dermal and incidental oral exposures for children contacting treated turf is anticipated. Residential exposure durations are expected to be short-term (up to several weeks) based on the residue dissipation data. Longer, intermediate-term exposures greater than 30 days are not anticipated for dermal, incidental oral, or inhalation routes of exposure from non-occupational sources of atrazine.

Residential Handler Exposures & Risk Estimates

The Agency has determined that residential and other non-occupational handlers are likely to be exposed during atrazine use. The anticipated use patterns and current labeling indicate 5 major exposure scenarios, based on the types of equipment that potentially can be used to make atrazine applications. The scenarios include:

- (1) mixing/loading/applying liquid formulations using a backpack sprayer,
- (2) mixing/loading/applying liquid formulations for application with a low pressure handwand,
- (3) mixing/loading/applying liquid formulations for hose-end sprayer,
- (4) loading/applying granular formulations with a push type spreader, and
- (5) loading/applying granular formulations with a bellygrinder (hand-cranked spreader).

Residential Handler Exposure Scenarios -- Data and Assumptions

Residential handler exposure assessments were completed by HED assuming an exposure scenario for residents which includes the following attire: short sleeved shirt, short pants, shoes and socks, and no gloves or respirator. The atrazine lawn applicator exposure study contained only persons wearing long sleeves, long pants, and gloves. The original hose-end sprayer study used for PHED had only 8 replicates, all of whom wore gloves, and all hand residues were non-detectable. The recently submitted ORETF exposure study data for push type granular spreader and hose-end sprayer had greater numbers of replicates and therefore greater statistical power than studies previously used in PHED. Therefore, in the absence of atrazine-specific data, the ORETF data will be used for those two scenarios, and the remaining handler exposure estimates will use PHED data. The ORETF surrogate study for granular application by residents is described below and in the official review memo. The hose-end sprayer exposure study will be described in this section. Surrogate PHED data used to estimate daily unit exposure values were taken from the *Standard Operating Procedures (SOPs) for Residential Exposure Assessments* (December 1997; revised 2/2001). Table 13 summarizes the caveats and parameters specific to the surrogate data used for each scenario and corresponding exposure/risk assessment. The following assumptions and factors were used in order to complete this exposure assessment (see also footnotes Tables 14-17):

- The duration of exposure is expected to be short-term (1-30) days based on label directions for multiple (not more than two) applications of atrazine to lawns. None of the currently registered residential or other non-occupational uses would result in intermediate- or long-term exposures.
- Calculations were completed at the maximum application rates for lawns recommended on the available atrazine labels to bracket exposure levels associated with the various use patterns.
- Generally, the use of PPE and engineering controls are not considered acceptable options for products sold for use by residents. Therefore, PHED values represent a handler wearing typical residential clothing attire of short-sleeve shirt, short pants, and no gloves.
- For short-term dermal and inhalation dose estimates, the mean body weight of an adult handler was assumed to be 70 kg since the short-term dermal endpoint is not sex specific.
- An estimate of 0.5 acres (approximately 20,000 ft²) treated per day was used for push-sprayer and hose-end scenarios. One-half acre is assumed to be within the mean to upper-percentile range of the distribution of lawn size.
- Backpack or and low-pressure hand wand application of liquid formulation are assumed to be used for a spot-treatment or areas where push type spreaders would be impractical. The area treated is assumed to be no more than 1000 sq ft. The label does not include (or prohibit) hand spreading of granulated product.

Handler Exposure Study Data:

See the occupational exposure section for a discussion of the atrazine study of lawn care operators. The ORETF studies of residential handlers applying granular and liquid formulations are summarized briefly here. More details are contained in the review memorandum.

Granular Push-Spreader:

A loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using Dacthal (active ingredient DCPA, dimethyl tetrachloroterephthalate) as a surrogate compound to determine “generic” exposures of 30 volunteers applying a granular pesticide formulation to residential lawns. As the data were mostly lognormally distributed, the geometric mean of the data were used and adjusted for the atrazine lawn application maximum rate of 2 lbs ai/acre.

ORETF Hose-end Spray Exposure Study:

Diazinon was chosen by the Task Force as the surrogate chemical for hose-end sprayers. A mixer/loader/applicator study was performed by the Outdoor Residential Exposure Task Force (ORETF) using diazinon (25% EC) as a surrogate compound to determine “generic” exposures to 30 individuals applying a pesticide to turf with a garden hose-end sprayer. Dermal and inhalation exposures were estimated using passive dosimetry techniques. A nominal application rate of 4 lb ai/acre was used for all replicates. Each replicate monitored the test subject treating 5,000 ft² of turf and handling a total of 0.5 lb ai/replicate. This study data is of greater quality and confidence than the current PHED data for hose-end spray. Due to extrapolation to ½ acre (a 4x increase) the geometric mean of the data was used, rather than the mean or 90th percentile, to avoid overestimating.

Residential Handler Exposure and Risk Estimates

The calculations of daily dermal and inhalation exposure to atrazine were used to calculate short-term dermal and inhalation doses, and hence the risks for residential handlers. The short-term dermal and inhalation doses were also combined. The MOE target for residential dermal or inhalation short-term exposure is 300; MOEs greater than these do not exceed the HED’s level of concern. Tables 14a & 14b present the residential dermal short-term doses and the MOEs associated with the residential handling of atrazine using PHED and ORETF data, respectively. The following formulae were used in calculation of dermal exposure, short-term dose and MOE.

Potential daily exposures were calculated using the following formulae:

$$\text{Daily Dermal Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) = \text{Unit Exposure} \left(\frac{\text{mg ai}}{\text{lb ai}} \right) \times \text{Use Rate} \left(\frac{\text{lb ai}}{\text{A}} \right) \times \text{Daily Acres Treated} \left(\frac{\text{A}}{\text{day}} \right)$$

$$\text{Daily Inhalation Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) = \text{Unit Exposure} \left(\frac{\mu\text{g ai}}{\text{lb ai}} \right) \times \text{Conversion Factor} \left(\frac{1\text{mg}}{1,000 \mu\text{g}} \right) \times \text{Use Rate} \left(\frac{\text{lb ai}}{\text{A}} \right) \times \text{Daily Acres Treated} \left(\frac{\text{A}}{\text{day}} \right)$$

Short-term inhalation and dermal doses (incidental oral ingestion is not considered a significant exposure route for adults) were calculated using the following formulae:

$$\text{Daily Dose} \left(\frac{\text{mg ai}}{\text{kg/day}} \right) = \text{Daily Exposure} \left(\frac{\text{mg ai}}{\text{day}} \right) \times \left(\frac{\text{Absorption Factor}(\frac{\text{percent}}{100})}{\text{body weight (kg)}} \right)$$

where: inhalation absorption factor is assumed to be 100 percent or 1

where: dermal absorption factor = 100 percent or 1 (dermal toxicity study used)

- Full lawn treatment: $\frac{1}{2}$ Acre x 1 to 2 lb ai/acre (depending on formulation) = 0.5 to 1 lb ai/day
- Spot-treatment: 1,000 ft²/day x (1 to 2 depending on formulation) lb ai/acre = 0.023 to 0.045 lb ai/day

The following formula was used in the calculation of the short-term MOEs:

$$\text{MOE (unitless)} = \frac{\text{NOAEL (mg / kg / day)}}{\text{Daily Dose (mg / kg / day)}}$$

Combined MOEs for short-term exposures were calculated using the following formula:

$$\text{Combined MOE} = \frac{1}{\frac{1}{\text{dermal MOE}} + \frac{1}{\text{inhalation MOE}}}$$

The same formula will be used for aggregating dermal, inhalation, and/or oral risks, as needed.

Handler Scenarios with Risk Concerns

Only one of the residential handler scenarios had short-term dermal risks of concern. Only application of granular formulation by belly grinder to one-half acre exceeded the level of concern with a dermal MOE of 66 and combined dermal + inhalation MOE of 65. All other

dermal and inhalation exposure MOEs were greater than the target MOE of 300 and the combined MOES ranged from 640-28,000 (Tables 14a & 14b).

Data Gaps

Surrogate data from passive dosimetry studies were available for each application method. Atrazine-specific handler exposure data were only available for closed mixing/loading systems and enclosed cab application by ground spray. The quality of data is discussed below.

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the resident handler risk estimates:

- The belly grinder method (like other hand-controlled applications) is a low-confidence estimate, but is considered to be generally conservative. If hand application methods are to be prevented, the labeling should explicitly specify. Unfortunately, the belly grinder equipment is readily available and used by consumers, yet results in much higher dermal exposure than a push spreader.
- The scenarios based on ORETF studies were extrapolated from the lower acreages applied in the studies by simple proportion, and this process may statistically overestimate the risk because the rate of residue increase on skin generally decreases somewhat after a certain (undetermined) level. However, the geometric mean value was used in order to offset the extrapolation and help represent a more typical, rather than high-end, dose.
- The use of one-half an acre for residential applications is based on the Revised Residential SOPs (2001), which states that recent lawn size survey data suggest that up to 0.5 acre represents 73% of the 2,300 respondents, while nearly 16% of the respondents had lawn sizes that ranged from 0.57 to 1 acre (Outdoor Residential Use and Usage Survey and National Gardening Association Survey 1999). Therefore one-half acre is a high-end estimate, but not a maximum. The label-recommended use of atrazine lawn products as weed prevention in spring and/or fall may support its use on the entire lawn, rather than as a spot treatment, since weeds may not be present at those times.
- The liquid backpack and low-pressure handwand scenarios used low-confidence PHED data from estimates found in the Residential SOPs. The backpack scenario had insufficient replicates (only 11), while the low-pressure handwand had low quality data.
- After review by PMRA Canada and the US EPA, the data from the ORETF studies has been classified as medium-to-high confidence level, due to adequate quality controls, numbers of replicates and quantifiable samples (above the limit of detection.) The data,

therefore, are generally of higher confidence than those in the same scenarios in PHED v. 1.1/Residential SOPs (1997).

Non-Occupational Postapplication Exposures and Risk Estimates

The Agency has determined that there are potential postapplication exposures to residents entering atrazine treated lawns, either as a result of commercial or private application.

Postapplication Exposure Scenarios

The scenarios likely to result in postapplication exposures are presented below. The duration of postapplication dermal exposure is expected to be short-term (less than 30 days). The initial transferable residues from spray application were much higher (6x) than granular residues, but both declined slowly. As calculated from the study data, atrazine has a half-life on turf of up to five days after spraying or nine days after granular application, requiring several weeks to dissipate to nondetectable levels of transferable residues. Because the label prohibits application more than twice per year, and even with the slow dissipation rates, it is not expected that individual residential exposure duration would exceed 30 days in duration. Exposure on a residential lawn would diminish continuously with time, while exposure through recreational turf contact would be more like random intermittent events of varying doses, all less than the dose predicted in this assessment. The resulting risk estimates are summarized in Table 15.

Residential postapplication exposure assessments assumed residents wear the following attire: short sleeved shirt, short pants, shoes and socks, and no gloves or respirator. As stated in the occupational postapplication risk section of this document, negligible atrazine inhalation exposure is anticipated for non-handlers, due to low chemical vapor pressure and dilution of vapor outdoors (this is borne out in handler study data). The scenarios likely to result in postapplication exposures are as follows:

- dermal postapplication risks to adults and children when entering atrazine treated turf and lawns;
- incidental oral postapplication risks to children from “non-dietary” (i.e., hand-to-mouth contact, mouthing contaminated objects off the lawn, ingestion of soil or granular pellets) exposure when reentering lawns treated with granular and spray formulations.

Representative turf reentry activities include, but are not limited to:

- (1) Adults involved in a low exposure activity, such as golfing or walking on treated turf.
- (2) Adults mowing or other moderate contact activity, for 1-2 hours.
- (3) Adults involved in a high exposure activity, such as heavy yard work (doses similar to occupational scenarios for cutting and harvesting sod).
- (4) Children involved in high exposure activities on turf.

Summary of Postapplication Spray Drift/Track-In Risks

HED recognizes that there may be concerns for the potential for children's exposure in the home as a result of agricultural uses of atrazine. Environmental concentrations of atrazine in homes may result from spray drift, track-in, or from redistribution of residues brought home on the farmworker's clothing. Potential routes of exposure for children may include incidental ingestion and dermal contact with residues on carpets/hard surfaces. Studies are currently being pilot-tested which will look for sources of major pesticide (including atrazine) exposure and attempt to quantify those exposures. A large study in the National Hazard Assessment Exposure Assessment Survey (NHEXAS) program [MacIntosh, et al., 1999] has thus far detected no or extremely low (less than 1 percent detectable, less than one ug per gram creatinine) levels of atrazine in 80 participants in Maryland.

This assessment reflects the Agency's current approaches for completing residential exposure assessments based on the guidance provided in the *Draft: Series 875-Occupational and Residential Exposure Test Guidelines, Group B-Postapplication Exposure Monitoring Test Guidelines*, the *Draft: Standard Operating Procedures (SOPs) for Residential Exposure Assessment*, and the *Overview of Issues Related to the Standard Operating Procedures for Residential Exposure Assessment* presented at the September 1999 meeting of the FIFRA Scientific Advisory Panel (SAP). The Agency is, however, currently in the process of revising its guidance for completing these types of assessments. Further research into children's exposures resulting from agricultural uses of pesticides are being conducted by the Agency's Office of Research and Development through the STAR (Science to Achieve Results) grant program. The STAR program can be accessed at <http://es.epa.gov/ncerqa/grants/>. Modifications to this assessment shall be incorporated as updated guidance becomes available. This will include expanding the scope of the residential exposure assessments by developing guidance for characterizing exposures from other sources already not addressed such as from spray drift; residential residue track-in; and exposures to farm worker children.

Data Sources for Scenarios Considered

Two turf transferable residue studies, using a granular and a spray application, were described in the occupational Postapplication Exposures and Risk Estimates section of this document. As the studies were found to be acceptable for the risk assessment, the highest mean residues were also used to estimate short-term (DAT 0-1) postapplication re-entry exposure for adults and children contacting atrazine treated turf.

In addition, a study was conducted by Syngenta Crop Protection, Inc., entitled "Children's Residential Exposure and Risk Assessment to Atrazine Treated Turf Using Hand Press Transfer Efficiency Data" (February 27, 2002) MRIDs 456223-10 and -11. The study and accompanying risk assessment report the data gathered from a turf hand press study conducted in October of 2001. The study was designed with input from the EPA Offices of Pesticides and Research and Development, and modeled on earlier work by Clothier, et al. and Camann, et al. Eleven adult volunteers were

trained to press their palms on a square of turf treated with atrazine granular formulation, simulating the approximate pressure applied by a young child (about 8 kg). Dry hands and hands moistened with a simulated saliva (Aerosol OT-75 0.01%) were pressed either once or seven times on the treated turf. Residues were then removed by wiping the hands twice with gauze moistened with the Aerosol OT solution and analyzed for atrazine. There was considerable variability in the quantity of atrazine residue removed by single and multiple hand presses, either wet or dry, on irrigated or non-irrigated plots of turf. The highest residue transfer occurred for wet hand presses on non-irrigated turf, but the range and magnitude of residue removed overlapped between single and multiple presses. The data sets from the single and multiple-press trials were analyzed by two-sample t-test and determined to be normal in distribution, with no significant difference between the means for the single- and seven-press sets. Therefore the data of both the single and multiple moistened hand press trials were averaged and residue transfer was determined to be 1.1 % of application rate. Dry hand presses averaged 0.26% to 0.53% of application rate for single and multiple hand presses on non-irrigated turf. On irrigated turf, there was less difference between the average turf residue removed by dry or wet hands: single presses removed an average of 0.041% to 0.068% for dry and wet hands; multiple presses removed 0.21% to 0.26% for wet and dry hands, respectively. The study had adequate quality controls and the results were corrected for field fortification recoveries. See Table 16.

Particle size and distribution information was submitted by Syngenta on 8 granular formulations. The granular product was described by Scotts as having the size of “beach sand.” If the particles are very fine, individual grains would be difficult to pick up, or even to see when applied on a lawn and if used according to label directions and soil incorporated, it is unlikely that Atrazine granules would be accessible to a child. Five of the eight compounds for which Syngenta submitted granular size data had greater than 50% of their particles of diameters greater than 2 mm. These granules are, by Syngenta’s description, large enough to be seen and possibly picked up by small children. It would take between 10-20 of such granules to make up the 0.4 grams of product assumed in the Residential SOPs. The HED scientists, using best available data, consider 10-20 granules to be a large number for small children ingest in a single event. The larger of the “weed and feed” (fertilizer/herbicide combination) granules would be considered more attractive and more likely to be consumed if readily visible and easily picked up by a child. The granules have been described as unpalatable, which may also limit consumption. Small children have limited manual dexterity, but there is also a concern for granular material adhering to sticky hands and fingers and potentially being mouthed. The hand-press study submitted reported few granules sticking to palms, but there is little quantitative data on this subject. Even a very small amount, less than a teaspoon of atrazine-containing “weed and feed” lawn fertilizer, if mouthed and swallowed by a small child would exceed the toxic level of concern. Therefore, HED recommends that the potential for incidental children’s exposure to Atrazine granules be mitigated through stringent label requirements for watering-in and spill clean-up.

All residential scenarios, where possible, utilized the atrazine TTR study data, which were based upon the maximum label application rates. Children’s exposure levels were calculated for the residential exposure assessment and for the purposes of completing an aggregate risk assessment that also considers exposure from dietary intake of food and water.

Assumptions Used in Postapplication Exposure Calculations

Dermal Exposure values on each day after application were calculated based on the following equation (see Residential 2.2 (1997): Postapplication dermal potential dose from pesticide residues on turf):

$$DE_{(t)} (\text{mg/day}) = (\text{TTR}_{(t)} (\mu\text{g}/\text{cm}^2) \times \text{TC} (\text{cm}^2/\text{hr}) \times \text{Hr/Day})/1000 (\mu\text{g}/\text{mg})$$

Where:

- DE = Dermal exposure at time (t) attributable for activity in a previously treated area (mg/day);
- TTR= Turf Transferable Residue at time (t) where the longest duration (t) is dictated by the kinetics observed in the TTR study;
- TC = Transfer Coefficient; and
- Hr = Exposure duration in hours.

The activities that were selected as the basis for the risk assessment are represented by the following transfer coefficients (for short-term endpoints):

- **Transfer Coefficient = 500 - 1000 cm²/hour** for adults involved in a low exposure activity on turf such as golfing or light work activities;
- **Transfer Coefficient = 14,500 cm²/hour** for adults involved in a high exposure activity on turf such as heavy yard work or laying sod; and
- **Transfer Coefficient = 5,200 cm²/hour** for children (1-6 year olds) involved in a high exposure activity. Based on the proposed changes to the Residential SOPs, transfer coefficients of 14,500 cm²/hr for adults and 5,200 cm²/hour for small children were used to calculate dermal exposures to treated turf.

The Agency's Residential SOPs contains guidance for considering children's exposure to treated turf. The dermal calculations, as noted above, were completed based on the guidance provided in the document. All nondietary exposures were also calculated using guidance from this document. Specifically, the kinds of nondietary exposures that were considered in this assessment include the following:

- **Dose from eating granules calculated using Residential SOP 2.3.1:** Postapplication potential dose among children from incidental, episodic nondietary ingestion of pesticide granules in the treated area.
- **Dose from hand to mouth activity calculated using Residential SOP 2.3.2:** Postapplication potential dose among small children from incidental nondietary ingestion of pesticide residues on residential lawns from hand-to-mouth transfer.

- **Dose from mouthing treated turf or contaminated objects calculated using Residential SOP 2.3.3:** Postapplication potential dose among children from the ingestion of pesticide treated turfgrass; and
- **Dose from incidental ingestion of soil calculated using Residential SOP 2.3.4:** Postapplication potential dose among children from the ingestion of soil in pesticide treated areas.

Although incidental exposures incurred by hand-to-mouth exposure are included as part of the nondietary risk assessment, these type of exposures are considered *episodic* in nature. Therefore, the granular ingestion is assessed as an individual event and is not combined with any other nondietary exposure. The hand-to-mouth, object mouthing, and eating of soil are considered more likely to co-occur, and thus are combined. Note that the hand-to-mouth scenario constitutes the largest incidental oral exposure component (see Table 17).

This first formula illustrates the method of calculating granular ingestion by children (SOP 2.3.1):

$$PDR = IgR \times F \times CF1$$

where:

$$\begin{aligned} PDR &= \text{potential dose rate (mg/day)} \\ IgR &= \text{ingestion rate of granular formulation (g/day)} \\ F &= \text{fraction of ai in dry formulation (unitless)} \\ CF1 &= \text{weight unit conversion factor to convert grams to milligrams (1000 mg/g)} \end{aligned}$$

It is assumed in the Residential SOP that a maximum of 0.3 gm/day dry pesticide will be ingested by young children. This is based on an application rate of 150 lb formulated product to a half acre. The amount of product per square foot would be approximately 3 g/ft², and a child is assumed to consume one-tenth of the product available in a square foot. This is believed to be an upper-percentile estimate. Since atrazine labels vary from 100-200 lb formulated product per half acre (or 22,000 ft²), the maximum ingestible granules was adjusted to 0.2-0.4 grams/day. The fraction of ai in granular formulations of atrazine varies from 0.42 to 1.5%.

The following demonstrates the method used to calculate exposures that are attributable to a child touching treated turf and then putting their hands in their mouth (SOP 2.3.2, revised 2000). For the granular postapplication exposure estimate, the DFR is replaced by the experimentally determined transfer rate:

$$PDR = (DFR * EF * SA * Freq * Hr * (1mg/1000\mu g))$$

where:

$$\begin{aligned} PDR &= \text{potential dose rate (mg/day)} \\ DFR(t) &= \text{(for sprayed turf) Dislodgeable Residue (5\%) on day of treatment (\mu g/cm^2);} \end{aligned}$$

EF = (for granular application) 1.1% of application rate for moist hands;
 SA = saliva extraction factor of 50% of total DFR;
 Freq = surface area of two fingers (cm²);
 Hr = frequency of hand-to-mouth events (events/hour); and
 Hr = exposure duration (hours).

As indicated above, the dislodgeable foliar residue represents the amount of pesticide that can be removed from turf by the (potentially wet) hands of a child, while the turf transferable residue represents the amount of chemical on the surfaces of treated leaves that can rub off on dry skin or clothing. The methodology used to obtain a TTR value could underestimate incidental oral exposures to children. The TTR data are designed to assess dermal exposure to pesticides using the choreographed activity Jazzercise, measured on dry cotton dosimeters, and do not address the transferability of residues by hands wetted with saliva. The 5% transfer factor is based on data by Clothier (1999). Dislodgeable foliar residue (not atrazine) data from a 1984 California study (MRID 402029-01) based on washing grass clippings report average DFRs of 0.8% to 5.7%, depending on methodology. These observations are based on empirical data, and support the use of the standard value of 5% of the applied rate being dislodgeable residue as cited in the revised Residential SOPs (2/01), rather than the much lower transferability factor from the TTR study. The surface area for 1-3 fingers used (20 cm²) is the median surface area for a toddler (age 3 years) as updated by the SAP meeting in 1999. The frequency of hand-to-mouth events is 20 events per hour as updated in the 1999 SAP meeting. The 2 hour duration value is a recommended value from the U.S. EPA Exposure Factors Handbook. This model for hand-to-mouth dose is based on the premise that a child puts 2-3 fingers in their mouths, 50% of the residues on the hands are transferred from the hands to the mouth (Extraction Factor), and that all of the dislodgeable residues available on the treated turf transfer to the child's hand each time they exhibit this behavior.

The following illustrates the approach used to calculate exposures that are attributable to a object-to-mouth exposure scenario, such as a child mouthing treated turf (SOP 2.3.3, revised 2000):

$$PDR = (DFR * IgR * (1mg/1000\mu g))$$

where:

PDR = potential dose rate (mg/day);
 DFR(t) = Dislodgeable Foliar Residue (DFR) at time (t) where the longest duration (t) is dictated by the kinetics observed in the TTR study (μg/cm²);
 IgR = ingestion rate for mouthing of grass (or other object) per day (cm²/day).

Lacking DFR data for atrazine on turf, such as would be dislodged by an object mouthed by a child, the Agency chose to use the standard assumptions in the updated Residential SOPs, normalized for lbs ai/acre applied. It is assumed that 5% of the applied rate (2 lb ai/A) is available for ingestion after being mouthed. The ingestion rate used (25 cm²/day) assumes that a child will grab a handful of turf, or a small object, mouth it and remove all dislodgeable atrazine residues, and then remove it from their mouth as described in the Residential SOPs. The standard time period is 2

hours, as explained above. The surface area of (25 cm²/day) is thought to approximate a handful of turf or a small object that is mouthed.

Incidental Soil Ingestion:

$$PDR = (SR_t * IgR * CF1)$$

where:

- PDR = potential dose rate (mg/day)
- SR_t = soil residue on day "t" (µg/g), assuming average day of reentry "t" is day 0
- IgR = ingestion rate of soil (mg/day), assumed to be 100 mg/day
- CF1 = weight unit conversion factor to convert the µg of residues on the soil to grams to provide units of mg/day (1E-6 g/µg)

and

$$SR_t = AR * F * (1-D)^t * CF2 * CF3 * CF4$$

where:

- AR = application rate (lb ai/acre)
- F = fraction of ai available in uppermost cm of soil (fraction/cm), assumed to be 100 percent based on soil incorporation into top 1 cm of soil after application
- D = fraction of residue that dissipates daily (unitless)
- t = postapplication day on which exposure is being assessed
- CF2 = weight unit conversion factor to convert the lbs ai in the application rate to µg for the soil residue value (4.54 x 10⁸ µg/lb)
- CF3 = area unit conversion factor to convert the surface area units (ft²) in the application rate to cm² for the SR value (2.47 x 10⁻⁸ acre/cm² if the application rate is per acre)
- CF4 = volume to weight unit conversion factor to convert the volume units (cm³) to weight units for the SR value (0.67 cm³/g soil)⁷
- t = postapplication day on which exposure is being assessed, assumed to be day zero

The following specific assumptions and factors were used in order to complete this exposure assessment:

- These assessments were based on the guidance provided in the Residential SOPs as updated in February, 2001 (described above). The standard assumption of 5% DFR was replaced by 1.1% for granular hand-to-mouth transfer based on atrazine-specific data. Several of the assumptions and factors used in the exposure assessment are described in that document.
- Calculations are completed at the maximum application rates recommended by the available atrazine labels to bracket risk levels associated with the various use patterns and activity scenarios. Although "typical" and average rates have been supplied, the atrazine

labels generally reflect a recommended rate for granular and liquid formulations which is at or close to the 2.0 lb ai/acre limit. The granular and spray turf residue data which were submitted also use the 2.0 lb ai/acre application rate. These were normalized to an exposure of mg/lb ai handled.

- Chemical-specific turf transferable residue data was used for estimation of dermal exposures.
- Due to a lack of scenario-specific exposure data, HED has calculated exposure values for adults using surrogate dermal transfer coefficients that represent activities such as mowing, golfing, and yard work. Most of the transfer coefficients used are based on data submitted by the ARTF and ORETF and are reflected in the revised HED exposure guidance Policy 3.1 (8/2000).
- Adults were assumed to weigh 70 kg for the short-term postapplication dermal dose estimate. Young children and toddlers are represented by a 15 kg 3 year old, as recommended in the Residential SOPs.
- Postapplication exposure is generally assessed on the same day the pesticide is applied because it is assumed that the resident could be exposed to turf immediately after application. However, because atrazine TTR study data indicate transferable residues are *greater* 4 to 12 hours after the initial application, the highest average residue from each site has been used for the screening risk estimate.
- MOEs were calculated using the same formula (NOAEL divided by absorbed dermal dose) described in the residential handler portion of this chapter, and are considered to be below the level of concern when results are greater than 300.

Postapplication Exposure Risk Estimates

Due to the variability of the TTR data, which were well characterized by the authors, dermal exposure estimates were conducted using the actual average TTR study residues from each site and the set of standard assumptions outlined above (see Table 15). Two of these scenarios, both using the higher of the 2 sites' average residue data from application of a liquid formulation, had short-term dermal MOEs less than the target of 300, for high-contact activities on wet turf for the child (MOE = 110) and adult (MOE = 190). When the average dry turf residue was used, the respective MOEs for the same activities were 620 for the child and 1000 for the adult. The highest average TTR from the (NC site) liquid application represents approximately 6% of the application rate, while the second highest average TTR (from the GA site) is about 1% of the application rate. These values bracket the usual range found in residues from TTR studies. Residues had dissipated sufficiently by the day after treatment *at both sites* to raise MOEs over 1000 for both children and adults. For granular treatments, all postapplication MOEs were greater than 300; MOEs for high-contact activities on turf ranged from 1200-21,000 for adults and from 690-13,000 for children. For adults golfing and mowing on treated turf, all short-term dermal MOEs were greater than or equal to

2800. If multiple adult dermal exposures (golfing, mowing, high-contact activities) occurred in a single day, the total dermal MOE would be no greater than the single lowest MOE, and depend on the formulation applied to the turf. The only total dermal risk estimates of concern would therefore include the single adult and child 'high-contact activity' on spray-treated turf that is wet.

The atrazine hand press study data were used to estimate non-dietary exposure on granular treated turf. Lacking DFR data for spray treated turf (because children's hands may be wet and sticky and TTR data was obtained with dry wipe methods), the Residential SOPs were used to estimate incidental oral exposure for toddlers (young children) from that scenario. The risk estimates for turf/object mouthing and soil ingestion are based on the application rate of 2 lbs ai/acre, and formulation is not a factor. The hand-to-mouth MOE for granular treated turf was 950 and a total non-dietary ingestion MOE of 730 was obtained. The hand-to-mouth MOE alone for sprayed turf was 210, which exceeds the level of concern. The mouthing grass and soil ingestion MOEs (3300 and 62,500, respectively), which were the same for both formulations, did not exceed the level of concern. The total (hand-to-mouth + mouthing grass + soil ingestion) incidental ingestion MOE for sprayed turf was 200, or nearly the same as the hand-to-mouth MOE alone. Incidental ingestion of atrazine granules was not combined with the other oral exposures, as it is considered episodic in nature, but all formulations had MOEs of concern (single dose; 0.42%-1.5% ai; MOE 16-110). Different granular fertilizers have different sizes of particles, so the ability of a child to pick up the material will vary with the formulation.

Aggregate Exposure Estimates

Adults may reasonably be expected to perform more than one activity on treated lawns in a single day, but an eight-hour exposure is considered unlikely. Therefore it is considered reasonable to add the exposures from mowing (low contact) and gardening (high contact), for example for a single MOE. Excepting the highest exposure activity on wet or damp, spray-treated turf, the combined MOE would be greater than the target 300. The combined postapplication MOEs would be no greater than the lowest single MOE. Small children are not expected to have significant gardening or mowing exposures, and the jazzercise exposure model is considered sufficiently conservative to cover daily dermal exposures. It is possible, if not very likely, that an adult would apply herbicide spray to a lawn and then play on it or mow it later that day. In such an event, the total dermal MOE for the day could exceed the level of concern, based on the liquid application study residue values, but not based on the granular residue data.

It is considered reasonably likely that dermal and oral incidental exposures may occur in the same day for children playing on atrazine-treated lawn. It can be seen from calculations presented in Table 17 that the incidental hand-to-mouth exposure estimate constitutes most of the total non-dietary oral dose. The overall incidental oral MOE is only slightly less (200 for spray, 730 for granular) than the MOE for the hand-to-mouth estimate (210 spray; 950 granular). The individual dermal and oral routes of exposure on sprayed turf each exceed the level of concern, and adding them mathematically produces an even lower MOE of 71, while the granular total MOE for dermal + oral incidental exposure is at least 350. These route-specific and dermal + oral aggregated doses and MOEs were calculated for the purposes of the overall risk assessment for this chemical, which will

consider all routes of exposure. Finally, ingestion of granules, as explained earlier, is not aggregated because it is considered an infrequent, episodic event.

Summary of Postapplication Risk Concerns

There is a risk concern (i.e., $MOE < 300$) for adult or child residential exposures during the early (less than seven days) postapplication period when playing/working intensively on damp, spray-treated turf. On dry lawns after spray treatment, or either formulation after the day of application, there is no longer a dermal exposure level of concern. Therefore, based on the study data, applying a liquid formulation and using the lawn the same day may cause an exposure of concern for adults or for the children playing on the lawn, particularly if it is wet. These were the only dermal exposure scenarios of concern for either adult or child.

Children's hand-to-mouth behaviors after touching damp, spray-treated turf, or the actual ingestion of granules are the two incidental oral ingestion scenarios of concern. Of these, the hand-to-mouth is considered most representative of actual events. The hand-to-mouth exposure from spray treated turf exceeds the short-term level of concern ($MOE = 210$) on wet turf, but none of the MOEs based on granular residues are of concern. The opportunity for incidental ingestion of granules may be reduced where particles are relatively small (less than 2 mm) and the turf is thick and upright (as in the southeastern U.S.), but as most formulations contain larger granules, labeling statements should also advocate prompt watering-in and clean up of spillage.

Data Gaps and Uncertainties

The following data gaps or uncertainties were associated with this assessment:

- Oral ingestion scenarios are based largely on standard assumptions and formulae (Residential SOPs) which are designed to be screening level. The Recommended Revisions to the Residential SOPs (02/01) include refinements of several of the activity factors. Overall, the revisions have resulted in more refined, less conservative SOPs. For example, the hand-to-mouth scenario now uses 3 fingers instead of the whole hand, a 50% saliva extraction factor instead of 100%, and the frequency selected is based on the 90th percentile of observed hand-mouth transfer frequency. Reed et al., (1999) reported hourly frequencies of hand-to-mouth events in pre school children aged 2 to 5 years based on observations using video tapes. The data consist of 20 children at daycare centers and 10 children at home. A range of 0 to 70 events per hour were reported. The 1999 SAP recommended the use of the 90th percentile value of 20 events. A mean of 9.5 events was also reported by Reed, which is similar to the mean reported by Zartarian et al., 1995 and 1997 using similar video tape techniques while observing 4 farmworker children (2-4 years).
- The day of application TTR values from each site were used for this risk assessment due to the variability of data between the study sites. The Residential SOPs also assume day-of-treatment residues. The risk estimates therefore represent the higher end of the

exposure range, but are not considered maximum values. Aggregating high-end estimates may magnify the conservatism of the assessment. The highest residues were from the TTR studies conducted without watering-in; watering-in of the granular formulations greatly reduced transferable residues, and is recommended on the label (as atrazine is a systemic herbicide).

- Granular ingestion is considered episodic, rather than continuous, in nature. Therefore this scenario is not considered to contribute to the aggregate dose.

Recommendations

The deterministic postapplication residential risk assessment, which used either the highest reported average daily residue levels, or the Residential SOPs, resulted in MOEs which exceed the Agency's level of concern. A probabilistic approach to the use of the various residue study data, application rates, areas treated per day, etc., would help to refine the aggregate risk estimates. Such an approach would result in an estimate of anticipated "typical" exposures. Information on residential usage patterns specific to atrazine could be used in such an analysis.

Current labeling should be strengthened to prevent accidental ingestion by children, and emphasize the importance of watering-in to prevent dermal or incidental oral exposure. Application of granular formulation by hand or hand held grinder should be prohibited on the label to prevent uneven distribution, which could contribute to accidental ingestion by children, pets, or wildlife.

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ATTACHMENT

ATRAZINE

EXPOSURE AND RISK ESTIMATES

TABLES 1-17

EPA OPP Barcode D282457

Table 1. Acute Toxicity Categories for Atrazine

| Guideline No. | Study Type | MRID #(s) | Results | Toxicity Category |
|---------------|-------------------------|-----------|-------------------------------|-------------------|
| 81-1 | Acute Oral | 00024709 | LD ₅₀ = 1869 mg/kg | III |
| 81-2 | Acute Dermal | 00024709 | LD ₅₀ >2000 mg/kg | III |
| 81-3 | Acute Inhalation | 43016502 | LC ₅₀ = >5.8 mg/L | IV |
| 81-4 | Primary Eye Irritation | 00024709 | PIS = 0.0/110 | IV |
| 81-5 | Primary Skin Irritation | 00024709 | PIS = 0.2/8.0 | IV |
| 81-6 | Dermal Sensitization | 00105131 | not a sensitizer | - |

L. Taylor 4/2002

| Guideline No. | Study Type | MRIDs # | Results | Toxicity Category |
|---------------|-------------------------|------------|--|-------------------|
| 81-1 | Acute Oral | Acc 230303 | LD ₅₀ = 1,869 mg/kg (M+F combined) | III |
| 81-2 | Acute Dermal | Acc 230303 | LD ₅₀ > 2,000 mg/kg (M+F combined) | III |
| 81-3 | Acute Inhalation | 430165-02 | LC ₅₀ > 5.8 mg/L (M+F combined) | IV |
| 81-4 | Primary Eye Irritation | Acc 230303 | PIS= 0.0/110 | IV |
| 81-5 | Primary Skin Irritation | Acc 230303 | PIS= 0.2/8.0 | IV |
| 81-6 | Dermal Sensitization | 001051-31 | Non-sensitizing | IV |
| 81-7 | Acute Neurotoxicity | none | Not Applicable | — |

Reference: Hawks, R. Atrazine - 2nd Report of the Hazard Identification Assessment Review Committee. August 28, 2000. US. EPA.

Table 2. Toxicity Endpoints for Assessing Occupational and Residential Risks for Atrazine

The doses and toxicological endpoints selected for various exposure scenarios are summarized below.

| EXPOSURE SCENARIO | DOSE (mg/kg/day) | ENDPOINT | STUDY |
|--|--|--|-------------------------------------|
| Incidental Oral, Short-Term | NOAEL= 6.25 UF x FQPA = 300 | Chronic Dietary | NOAEL = 1.8 UF = 100 |
| Incidental Oral, Intermediate-Term | NOAEL= 1.8 UF x FQPA = 300 | | |
| Dermal, Short-Term | NOAEL= <u>6.25</u> = 104 6% dermal absorption Occupational UF = 100 Residential UF = FQPA=300 | Delay in preputial separation | 30-day rat pubertal survey |
| Dermal, Intermediate-Term ^a | NOAEL= 1.8 Occupational UF = 100 | Attenuation of the pre-ovulatory luteinizing hormone (LH) surge as indicative of hypothalamic disruption | Six-month LH surge study in the rat |
| Dermal, Long-Term ^a | NOAEL= 1.8 Occupational UF = 100 | Same as intermediate term | Same as intermediate term |
| Inhalation, Short-Term ^b | NOAEL= 6.25 Occupational UF = 100 Residential UF x FQPA= 300 | Delay in preputial separation | 30-day rat pubertal survey |
| Inhalation, Intermediate-Term ^b | NOAEL= 1.8 Occupational UF = 100 | Attenuation of the pre-ovulatory luteinizing hormone (LH) surge indicative of hypothalamic disruption | Six-month LH surge study in the rat |
| Inhalation, Long-Term ^b | NOAEL= 1.8 Occupational UF = 100 | Same as intermediate term | Same as intermediate term |

Footnotes:

a) Dermal absorption rate = 6%

b) Convert from oral dose using an inhalation absorption rate= 100% default

Table 3: Atrazine: Occupational Handler Short-term and Intermediate-term Risk Estimates; Based on Field Monitoring of Atrazine Handlers Using Engineering Controls (Biomonitoring and Passive Dosimetry Studies)

| Exposure Scenario | Crop Type | Application Rate ^a | Acres Treated ^b | Data Type and Source | Engineering Control Unit Exposure (mg/lb ai) | | Short-Term Risks | | | | Intermediate-Term Risks | |
|--|---------------|-------------------------------|----------------------------|---------------------------------------|--|--------------------------------|--------------------------------|--------------------------------|---------------------------|-----------------------------|--------------------------------|-------------------------|
| | | | | | Geo Mean | 90 th Percentile | Dose (mg/kg/day) | | Engineering Control MOE | | Absorbed Dose (mg/kg/day) | Engineering Control MOE |
| | | | | | | | Geo Mean | 90 th Percentile | Geo Mean | 90 th Percentile | Geo Mean | Geo Mean |
| Mixer/Loader | | | | | | | | | | | | |
| Mixing/Loading Liquid Formulations for Groundboom Application (1b) | corn, sorghum | 2 | 200 | Passive Dosimetry norm by ai (#09/11) | 0.00860 ^c dosimeters | 0.1600 ^c dosimeters | 0.049 ^e dermal | 0.91 ^e dermal | 2100 ^g dermal | 114 ^g dermal | 0.0029 ^e abs.drml | 610 ^g dermal |
| | | | | Biomonitoring norm by ai (#09/11) | 0.00058 ^d urinary | 0.0044 ^d urinary | 0.0033 ^f tot. intrl | 0.025 ^f tot. intrl | 1,900 ^h total | 250 ^h total | 0.0033 ^f tot. intrl | 550 ^h total |
| | | NA | NA | Biomonitoring norm by bw (#05/06) | NA | NA | 0.0029 ^f tot. intrl | 0.012 ^f tot. intrl | 2,200 ^h total | 520 ^h total | 0.0029 ^f tot. intrl | 620 ^h total |
| | | NA | NA | Biomonitoring norm by bw (#09/11) | NA | NA | 0.0033 ^f tot. intrl | 0.013 ^f tot. intrl | 1,900 ^h total | 480 ^h total | 0.0033 ^f tot. intrl | 550 ^h total |
| Applicator | | | | | | | | | | | | |
| Applying Liquids for Groundboom Application (5) | corn, sorghum | 2 | 200 | Passive Dosimetry norm by ai (#09/11) | 0.012 ^c dosimeters | 0.49 ^c dosimeters | 0.069 ^e dermal | 2.8 ^e dermal | 1,500 ^e dermal | 37 ^h dermal | 0.0041 ^e abs.drml | 430 ^g dermal |
| | | | | Biomonitoring norm by ai (#09/11) | 0.00061 ^d urinary | 0.0069 ^d urinary | 0.0035 ^f tot. intrl | 0.039 ^f tot. intrl | 1,800 ^f total | 160 ^h total | 0.0035 ^f tot. intrl | 510 ^h total |
| | | NA | NA | Biomonitoring norm by bw (#05/06) | NA | NA | 0.0011 ^f tot. intrl | 0.0038 ^f tot. intrl | 5,700 ^f total | 1600 ^h total | 0.0011 ^f tot. intrl | 1600 ^h total |
| | | NA | NA | Biomonitoring norm by bw (#09/11) | NA | NA | 0.0019 ^f tot. intrl | 0.014 ^f tot. intrl | 3,300 ^f total | 450 ^h total | 0.0019 ^f tot. intrl | 950 ^h total |
| Mixer/Loader/Applicator | | | | | | | | | | | | |
| Mixing/Loading/ Applying Liquids with Groundboom | corn, sorghum | 2 | 200 | Passive Dosimetry norm by ai (#09/11) | 0.021 ^c dosimeters | 0.190 ^c dosimeters | 0.12 ^e dermal | 1.1 ^e dermal | 870 ^h dermal | 95 ^h dermal | 0.0084 ^e abs.drml | 210 ^g dermal |
| | | | | Biomonitoring norm by ai (#09/11) | 0.0039 ^d urinary | 0.017 ^d urinary | 0.022 ^f tot. intrl | 0.097 ^f tot. intrl | 280 ^h total | 64 ^h total | 0.022 ^f tot. intrl | 82 ^h total |
| | | NA | NA | Biomonitoring norm by bw (#05/06) | NA | NA | 0.0042 ^f tot. intrl | 0.014 ^f tot. intrl | 1,500 ^h total | 450 ^h total | 0.0042 ^f tot. intrl | 430 ^h total |
| | | NA | NA | Biomonitoring norm by bw (#09/11) | NA | NA | 0.0055 ^f tot. intrl | 0.022 ^f tot. intrl | 1,100 ^h total | 280 ^h total | 0.0055 ^f tot. intrl | 330 ^h total |

NOTE: Exposure scenarios assume engineering controls (closed mixing/loading systems and enclosed cab groundboom application).

^a Application rate is the maximum EPA-registered label rate for corn /sorghum..

^b Acres treated per day value is the EPA estimate found in Exposure SAC Policy # 9 “Standard Values for Daily Acres Treated in Agriculture,” revised June 23, 2000.

^c Engineering control dermal unit exposure values calculated from passive dosimetry data presented in MRID 441521-09/11. Unit exposure = atrazine residue on inner dosimeters including head patch,

- face/neck wipes, hand washes, legs, t-shirt and briefs, torso / lb ai of atrazine handled per day. Unit exposure values are presented as the geometric mean value and the 90th percentile value.
- d Engineering control total internal unit exposure values calculated from biomonitoring data presented in MRID 441521-09/11. Unit exposure = total triazine residue in urine per replicate adjusted (divided by chlorotriazine excretion rate of 0.12) to represent atrazine internal exposure and then divided by total pounds of atrazine active ingredient handled per replicate. Unit exposure values are presented as the geometric mean value and the 90th percentile value.
- e Total dermal dose (mg/kg/day) = unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg developmental female for intermediate-term). For intermediate-term a dermal absorption factor of 6% is also included in the dose calculation.
- f Total internal dose is calculated from biomonitoring data presented in MRID 441521-05/06 and 441521-09/11. Total internal dose = highest daily triazine residue in urine per test subject and adjusted (divided by 0.12) to represent atrazine internal exposure and then divided by body weight of the test subject. Then selecting the geometric mean and 90th percentile of all such doses per handler activity (i.e., mixer/loader, applicator, and mixer/loader/applicator. Total internal dose values are presented as the geometric mean value and the 90th percentile value.
- g Dermal MOE = NOAEL (104 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term) / dermal dose (mg/kg/day).
- h Total MOE = oral NOAEL (6.25 mg/kg/day for short-term and 1.8 mg/kg/day for intermediate-term) / internal dose (mg/kg/day).

norm by ai = data normalized by active ingredient

norm by bw = data normalized by subject body weight

abs. drml = absorbed dermal

tot. intrl = total internal

05/06 = MRID 445976-05/06

09/11 = MRID 441521-09/11

Table 4: Atrazine: Occupational Exposure Scenario Descriptions and Data Sources

| Exposure Scenario (Number) | Data Source | Standard Assumptions | Comments |
|--|---|--|--|
| Occupational Mixer/Loader Exposure | | | |
| Mixing/Loading Liquid Formulations (1a, 1b, 1c, 1d., 1e, and 1f) | PHED V1.1 | 1,200 and 350 acres for aerial, 450 (based on study), 200, 80 and 40 acres groundboom; 40 acres for roadsides or rights-of-way; 100 acres for lawn handgun application (M/L for 20 trucks capable of treating 5 acres each); commercial admixture: 500-960 tons of fertilizer at 400 lbs/A. Private admixture: 160 acres | <p>Baseline: Dermal (72-122 replicates); hand (53 replicates); and inhalation (85 replicates) exposure values are all based on AB grade data. High confidence in the unit exposure values. No protection factors were needed to define the unit exposure values.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (59 replicates) exposure value is based on is based on AB grade data. High confidence in the unit dermal exposure value.</p> <p>Engineering Controls (closed mixing systems): Dermal (31 replicates), gloved-hand (31 replicates), and inhalation (27 replicates) exposure values are based on AB grade data. High confidence in the dermal unit exposure value. Low confidence in inhalation unit exposure value. No protection factors were needed to define the unit exposure value.</p> |
| | Novartis MRID 443154-04 combined with PHED V1.1 | same as above | <p>Baseline and PPE: no data</p> <p>Engineering Controls: (closed mixing systems): PHED as listed above; MRID 443154-04 dermal, gloved-hand, and inhalation (14 replicates) .</p> |
| Mixing/Loading Dry Flowable Formulations (2a, 2b, 2c) | PHED V1.1 | 1,200 (high acreage) and 350 acres for aerial; 450 (based on corn study), 200, 80 and 40 acres for groundboom; 40 acres for roadsides / rights-of-way | <p>Baseline: Dermal (16-26 replicates); hand (7 replicates); and inhalation (23 replicates) exposure values are all based on AB grade data. Low confidence in hand/dermal data due to the low number of hand replicates. High confidence inhalation data. No protection factor was needed to define the unit exposure value.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Hand (21 replicates) exposure values are based on AB grade data. High confidence in the dermal unit exposure value.</p> <p>Engineering Controls (water soluble packets): Gloved-hand (5 replicates) and dermal (6-15 replicates) exposure values are based on AB grade data. Inhalation (15 replicates) exposure value is based on all grade data. No protection factor was needed to define the unit exposure value.</p> |
| Loading Granular Formulations (3) | PHED V1.1 | 80 acres for sod farms and 40 acres for golf course turf | <p>Baseline: Hand (10 replicates) exposure values are based on all grade data, dermal (33-78) exposure values are based on ABC grade data , and inhalation (58 replicates) exposure values are based on AB grade data. Low confidence in hand/dermal data, and high confidence in inhalation data. No protection factor was needed to define the unit exposure value.</p> <p>PPE: The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator. Hand (45 replicates) and double layer (12-59 replicates) exposure values are based on ABC grade data. Medium confidence in baseline + gloves data; low confidence in double layer + gloves data. .</p> <p>Engineering Controls (Lock 'n Load): The same data are used as for baseline coupled with a 98% protection factor to account for Lock 'n Load.</p> |

| Exposure Scenario (Number) | Data Source | Standard Assumptions | Comments |
|---|-------------------------|--|--|
| Occupational Applicator Exposure | | | |
| Aerial Spray Application (4) | PHED V1.1 | 350 acres 1200 acres for high-acreage crops (less than 30 days based on supplemental data) | <p>Baseline and PPE: Insufficient data.</p> <p>Engineering controls (enclosed cockpit) : Dermal (24 to 48 replicates) and inhalation (23 replicates) exposure values are based on ABC grade data. Hand (34 replicates) exposure value is based on AB grade data. Medium confidence in the unit exposure values. No protection factors were needed to define the unit exposure</p> |
| Groundboom Application (5) | PHED V1.1 | 450 (based on corn study), 200, 80, and 40 acres | <p>Baseline: Dermal (23 to 42 replicates); hand (29 replicates); and inhalation (22 replicates) exposure values are based on AB grade data. High confidence in the unit exposure values. No protection factors were required to define the unit exposure value.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, if needed, with a 50% protection factor to account for an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (21 replicates) exposure value is based on ABC grade data. Medium confidence in the unit exposure value.</p> <p>Engineering Controls (enclosed cab): Dermal (20 to 31 replicates) and hand (16 replicates) exposure values are based on ABC grade data. Inhalation (16 replicates) exposure value is based on AB grade data. Medium confidence in dermal unit exposure value, and high confidence in the inhalation unit exposure value. No protection factors were required to define the unit exposure value.</p> |
| | Novartis MRID 443154-04 | same as above | <p>Baseline and PPE: no data</p> <p>Engineering Controls: (enclosed cab): PHED as listed above; MRID 443154-04 dermal, hand, and inhalation (14 replicates) .</p> |
| Applying Liquids with Rights-of-Way Sprayer (6) | PHED V1.1 | 40 acres | <p>Baseline: Dermal (4 to 20 replicates) exposure value is based on ABC grade data. Hand (16 replicates) exposure value based on AB grade data and inhalation (16 replicates) exposure value is based on A grade data. Low confidence in the dermal unit exposure value and high confidence in the inhalation data. No protection factors were needed to define the unit exposure value.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, if needed, with a 50% protection factor to account for an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (4 replicates) exposure value is based on AB grade data. Low confidence in the dermal/hand unit exposure value.</p> <p>Engineering Controls: Not available for this scenario.</p> |
| Applying Liquids with a Handgun (7) ORETF Study | ORETF OMA002 | 5 acres | <p>Baseline: Inhalation (40 replicates) exposure value is based on B grade date. Moderate to high confidence in inhalation data.</p> <p>PPE: A total 30 replicates site were monitored while they performed spray application only (using 75% wettable powder formulation). Using the grading criteria in Table 2, the data for this study are for the most part “B” or better, and the study meets the criterion for minimum replicates (15 or more per body part). Therefore OMA002 may be ranked “high confidence” data and is used instead of lower confidence PHED data. Most residues were above the limit of quantitation. If needed, a 50% protection factor is applied to the dermal data to account for an additional layer of clothing. The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator.</p> <p>Engineering Controls: Not available for this scenario</p> |

| Exposure Scenario (Number) | Data Source | Standard Assumptions | Comments |
|---|-------------|---|--|
| Applying with a Tractor Drawn Spreader (8 and 9) | PHED V1.1 | 200 (high acreage crop), 80 and 40 acres (golf course) Fertilizer: commercial 320 acres; private 160 acres | <p>Baseline: Dermal (1-5 replicates); hand (5 replicates); and inhalation (5 replicates) exposure values are all based on AB grade data. Low confidence in the unit exposure values. No protection factors were needed to define the unit exposure values.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (0 replicates) exposure value is low confidence due to lack of data.</p> <p>Engineering Controls: (enclosed cab): Dermal (2-30 replicates), hand (24 replicates), and inhalation (37 replicates) exposure values are based on AB grade data. High confidence in the dermal unit exposure value. Low confidence in inhalation unit exposure value. No protection factors were needed to define the unit exposure value.</p> |
| Occupational Mixer/Loader/Applicator Exposure | | | |
| Backpack Sprayer - Liquid Formulations (10) | PHED V1.1 | 5 acres (full) or 40 gal 1 acre (spot treatment) [atrazine liquid labels require 40 gal/acre] | <p>Baseline: Inhalation (11 replicates) exposure value is based on A grade data. Low confidence in the unit exposure value. No protection factors were needed to define the unit exposure value.</p> <p>PPE: Hand (11 replicates) exposure value data is based on C grade data. Dermal (9-11 replicates) exposure value is based on AB grade data. Low confidence in hand/dermal data. If needed, a 50% protection factor is applied to the dermal data to account for an additional layer of clothing. The same inhalation data are used as for the baseline coupled with an 80% protection factor to account for the use of a dust/mist respirator.</p> <p>Engineering Controls: Not available for this assessment.</p> |
| Low Pressure Handwand - Liquid Formulation (LCO) (11) | PHED V1.1 | 5 acres (full) or 40 gal 1 acre (spot treatment) [atrazine liquid labels require 40 gal/acre] | <p>Baseline: Dermal (9 to 80 replicates) and inhalation (80 replicates) exposure values are based on ABC grade data. Hand (70 replicates) exposure value is based on all grade data. Low confidence in the dermal and hands unit exposure values. Medium confidence in the inhalation unit exposure value. No protection factors were needed to define the unit exposure value.</p> <p>PPE: The same dermal, inhalation, and hand data are used as for baseline coupled, if needed, with a 50% protection factor to account for the use of an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved hand (10 replicates) exposure value is based on ABC grade data. Low confidence in gloved hand data.</p> <p>Engineering Controls: Not available for this assessment.</p> |

| Exposure Scenario (Number) | Data Source | Standard Assumptions | Comments |
|--|---------------------|------------------------------------|--|
| Lawn Handgun (and Compressed Air Sprayer) - Liquid Formulations (LCO) (12a); Water Dispersable Granules (WDG) (12b); Wettable Powder in Water Soluble Bag (WSB) (12c). | ORETF Study OMAA002 | 5 acres | <p>Baseline: No dermal data for these scenarios (could be back-calculated from study data using standard assumptions but no-glove scenario is not usual practice). Inhalation (15 replicates each scenario) exposure value is based on B grade data. Moderate to high confidence in inhalation data.</p> <p>PPE: Dermal (15 replicates) and inhalation (15 replicates) data of high confidence, grade "B" or better, were used to establish exposure values for each of the scenarios. A 50% protection factor was added to account for the use of an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Gloved hand (60 replicates) data were used to establish an exposure value.</p> <p>Engineering Controls: Water soluble bags are considered an engineering control for wettable powder formulations. Data for mixing/loading/applicator exposure based on commercial systems with some exposure controls during mixing/loading. No fully closed system available for this scenario.</p> |
| Loading and Applying Granulars with a Push Type Spreader (LCO) (13) | ORETF Study OMA001 | 5 acres | <p>Baseline: Hand (20 ungloved replicates), dermal (40 replicates) and inhalation (40 replicates) data were used to establish unit exposure values.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (20 replicates) data used to establish exposure value.</p> <p>Engineering Controls: Not available for this scenario.</p> |
| Granulars with a Bellygrinder (LCO) (14) | PHED V1.1 | 1 acre for spot treatments to turf | <p>Baseline: Dermal (29-45 replicates); hand (23 replicates) exposure values based on ABC grade data. Inhalation (40 replicates) exposure value is based on AB grade data. Medium confidence in dermal/hand data and high confidence in the inhalation unit exposure value. No protection factors were needed to define the unit exposure values.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, when needed, with a 50% protection factor to account for an additional layer of clothing and a 80% protection factor to account for the use of a dust/mist respirator. Gloved-hand (20 replicates) exposure value is based on all grade data. Low confidence in gloved hand data.</p> <p>Engineering Controls: Not available for this scenario.</p> |
| Occupational Flagger Exposure | | | |

| Exposure Scenario (Number) | Data Source | Standard Assumptions | Comments |
|----------------------------|-------------|---|--|
| Flagging Sprays (15) | PHED V1.1 | 350 acres (higher acreage uses mechanical or electronic flagging) | <p>Baseline: Dermal (18 to 28 replicates); hand (30 replicates); and inhalation (28 replicates) exposure values are based on AB grade data. High confidence in the unit exposure values. No protection factors were needed to define the unit exposure value.</p> <p>PPE: The same dermal and inhalation data are used as for the baseline coupled, if needed, with a 50% protection factor to account for the use of an additional layer of clothing and an 80% protection factor to account for the use of a dust/mist respirator. Hand (6 replicates) exposure value is based on AB grade data (not used). Low confidence in the gloved hand unit exposure value.</p> <p>Engineering Controls (enclosed cab): Data is based on groundboom enclosed cab. Dermal (20 to 31 replicates); hand (16 replicates); and inhalation (16 replicates) exposure values are based on ABC grade data for dermal and hands and AB grade data for inhalation. Medium confidence for hands and dermal and high confidence for inhalation.</p> |

^a Standard assumptions are based on the activities of a typical individual over a daily 8 hour interval. Occupational scenarios reflect what individuals could accomplish in an 8 hour workday.

^b Data quality assessments are based on the PHED grading criteria and the guidance provided in the Dec 1997 surrogate exposure table. Acceptable grades are matrices with grade A and/or B data. The PHED surrogate exposure table upon which this assessment is based was developed using the best data available in the system that are appropriate to the exposure scenario. Data confidence descriptors are assigned as follows:

High = grades A and B and 15 or more replicates;

Medium = grades A, B, and C and 15 or more replicates; and

Low = grades A, B, C, D, and E or any combination of grades with less than 15 replicates

| Table 5: Atrazine: Short-term Baseline Handler Exposure and Risk Estimates | | | | | | | | | | | Intermediate-term Risk Estimates | | | | |
|---|---|---|---|---|--|--------------------------------|-------------------------------|------------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|------------------------------------|-----------------------------------|---|
| Exposure Scenario | Crop Type | Applica- tion Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer/ day (b) | Baseline Dermal Unit Exposure (mg/lb ai) (c) | Baseline Inhalation Unit Exposure (ug/lb ai) (d) | Baseline Dermal Dose (e) | Baseline Dermal MOE (f) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (f) | Baseline Aggregate MOE (f) | Baseline Dermal Dose (e) | Baseline Dermal MOE (g) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (h) | Aggregate MOE (Baseline Dermal + Inh) (h) |
| Mixer/Loader | | | | | | | | | | | | | | | |
| Mixing/Loading Liquid Formulations for Aerial Application (1a) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL | 4 | 350 | 2.9 | 1.2 | 58 | 1.8 | 0.024 | 260 | 1.8 | 4.1 | 0.44 | 0.028 | 64 | 0.44 |
| | sugarcane | 2.6 | 350 | 2.9 | 1.2 | 38 | 2.8 | 0.016 | 400 | 2.7 | 2.6 | 0.68 | 0.018 | 99 | 0.68 |
| | chemical fallow | 3 | 1200 | 2.9 | 1.2 | 150 | 0.7 | 0.062 | 100 | 0.7 | 10 | 0.17 | 0.072 | 25 | 0.17 |
| | chemical fallow | 3 | 350 | 2.9 | 1.2 | 44 | 2.4 | 0.018 | 350 | 2.4 | 3 | 0.59 | 0.021 | 86 | 0.59 |
| | chemical fallow | 1.4 | 1200 | 2.9 | 1.2 | 70 | 1.5 | 0.029 | 220 | 1.5 | 4.9 | 0.37 | 0.034 | 54 | 0.37 |
| | chemical fallow | 1.4 | 350 | 2.9 | 1.2 | 20 | 5.1 | 0.0084 | 740 | 5.1 | 1.4 | 1.3 | 0.0098 | 180 | 1.3 |
| | CRP/grasslands | 2 | 1200 | 2.9 | 1.2 | 99 | 1 | 0.041 | 150 | 1.0 | 7 | 0.26 | 0.048 | 38 | 0.26 |
| | CRP/grasslands | 2 | 350 | 2.9 | 1.2 | 29 | 3.6 | 0.012 | 520 | 3.6 | 2 | 0.89 | 0.014 | 130 | 0.88 |
| | corn, sorghum | 2 | 1200 | 2.9 | 1.2 | 99 | 1 | 0.041 | 150 | 1.0 | 7 | 0.26 | 0.048 | 38 | 0.26 |
| | corn, sorghum | 2 | 350 | 2.9 | 1.2 | 29 | 3.6 | 0.012 | 520 | 3.6 | 2 | 0.89 | 0.014 | 130 | 0.88 |
| | corn, sorghum | 1 | 1200 | 2.9 | 1.2 | 50 | 2.1 | 0.021 | 300 | 2.1 | 3.5 | 0.52 | 0.024 | 75 | 0.51 |
| | corn, sorghum | 1 | 350 | 2.9 | 1.2 | 15 | 7.2 | 0.006 | 1000 | 7.1 | 1 | 1.8 | 0.007 | 260 | 1.8 |
| | sod farms | 2 | 350 | 2.9 | 1.2 | 29 | 3.6 | 0.012 | 520 | 3.6 | 2 | 0.89 | 0.014 | 130 | 0.88 |
| Mixing/Loading Liquid Formulations for Groundboom Application (1b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 2.9 | 1.2 | 13 | 7.8 | 0.0055 | 1100 | 7.8 | 0.93 | 1.9 | 0.0064 | 280 | 1.9 |
| | sugarcane | 2.6 | 80 | 2.9 | 1.2 | 8.6 | 12 | 0.0036 | 1800 | 12.0 | 0.6 | 3 | 0.0042 | 430 | 3 |
| | chemical fallow | 3 | 450 | 2.9 | 1.2 | 56 | 1.9 | 0.023 | 270 | 1.8 | 3.9 | 0.46 | 0.027 | 67 | 0.46 |
| | chemical fallow | 3 | 200 | 2.9 | 1.2 | 25 | 4.2 | 0.01 | 610 | 4.2 | 1.7 | 1 | 0.012 | 150 | 1 |
| | chemical fallow | 1.4 | 450 | 2.9 | 1.2 | 26 | 4 | 0.011 | 580 | 4.0 | 1.8 | 0.99 | 0.013 | 140 | 0.98 |
| | chemical fallow | 1.4 | 200 | 2.9 | 1.2 | 12 | 9 | 0.0048 | 1300 | 8.9 | 0.81 | 2.2 | 0.0056 | 320 | 2.2 |
| | CRP/grasslands | 2 | 450 | 2.9 | 1.2 | 37 | 2.8 | 0.015 | 410 | 2.8 | 2.6 | 0.69 | 0.018 | 100 | 0.68 |
| | CRP/grasslands | 2 | 200 | 2.9 | 1.2 | 17 | 6.3 | 0.0069 | 910 | 6.2 | 1.2 | 1.6 | 0.008 | 230 | 1.5 |
| | corn, sorghum | 2 | 450 | 2.9 | 1.2 | 37 | 2.8 | 0.015 | 410 | 2.8 | 2.6 | 0.69 | 0.018 | 100 | 0.68 |
| | corn, sorghum | 2 | 200 | 2.9 | 1.2 | 17 | 6.3 | 0.0069 | 910 | 6.2 | 1.2 | 1.6 | 0.008 | 230 | 1.5 |
| | corn, sorghum | 1 | 450 | 2.9 | 1.2 | 19 | 5.6 | 0.0077 | 810 | 5.5 | 1.3 | 1.4 | 0.009 | 200 | 1.4 |
| | corn, sorghum | 1 | 200 | 2.9 | 1.2 | 8.3 | 13 | 0.0034 | 1800 | 12 | 0.58 | 3.1 | 0.004 | 450 | 3.1 |
| | roadsides | 1 | 40 | 2.9 | 1.2 | 1.7 | 63 | 0.00069 | 9100 | 62 | 0.12 | 16 | 0.0008 | 2300 | 15 |
| | bermuda grass rights of way | 4 | 40 | 2.9 | 1.2 | 6.6 | 16 | 0.0027 | 2300 | 16 | 0.46 | 3.9 | 0.0032 | 560 | 3.9 |
| | golf course turf | 2 | 40 | 2.9 | 1.2 | 3.3 | 31 | 0.0014 | 4600 | 31 | 0.23 | 7.8 | 0.0016 | 1100 | 7.7 |
| | sod farms | 2 | 80 | 2.9 | 1.2 | 6.6 | 16 | 0.0027 | 2300 | 16 | 0.46 | 3.9 | 0.0032 | 560 | 3.9 |
| Mixing/Loading Liquid Formulations for Rights-of- Way Sprayer (1c) | roadsides | 1 | 40 | 2.9 | 1.2 | 1.7 | 63 | 0.00069 | 9100 | 62 | 0.12 | 16 | 0.0008 | 2300 | 15 |
| | bermuda grass rights of way | 4 | 40 | 2.9 | 1.2 | 6.6 | 16 | 0.0027 | 2300 | 16 | 0.46 | 3.9 | 0.0032 | 560 | 3.9 |

| Table 5: Atrazine: Short-term Baseline Handler Exposure and Risk Estimates | | | | | | | | | | | Intermediate-term Risk Estimates | | | | |
|--|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|----------------------------|----------------------------------|-------------------------|------------------------------|-----------------------------|---|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | Baseline Dermal Unit Exposure (mg/lb ai) (c) | Baseline Inhalation Unit Exposure (ug/lb ai) (d) | Baseline Dermal Dose (e) | Baseline Dermal MOE (f) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (f) | Baseline Aggregate MOE (f) | Baseline Dermal Dose (e) | Baseline Dermal MOE (g) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (h) | Aggregate MOE (Baseline Dermal + Inh) (h) |
| Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d) | lawns, golf courses | 2 | 100 | 2.9 | 1.2 | 8.3 | 13 | 0.0034 | 1800 | 12 | 0.58 | 3.1 | 0.004 | 450 | 3.1 |
| Mixing/ Loading/ Incorporating Liquid Formulations onto Liquid or Dry Bulk Fertilizer (1e) | commercial fertilizer for corn, sorghum: * PHED data | 2 | 960 tons | 2.9 | 1.2 | See Engineering Controls | | | | | See Engineering Controls | | | | |
| | | | 500 tons | | | See Engineering Controls | | | | | See Engineering Controls | | | | |
| | | | 500 tons | | | See Engineering Controls | | | | | See Engineering Controls | | | | |
| | commercial fertilizer for corn, sorghum: PHED data | 1 | 960 tons | 2.9 | 1.2 | See Engineering Controls | | | | | See Engineering Controls | | | | |
| | | | 500 tons | | | See Engineering Controls | | | | | See Engineering Controls | | | | |
| | | | 500 tons | | | See Engineering Controls | | | | | See Engineering Controls | | | | |
| | on-farm fertilizer for corn, sorghum | 2 | 160 | 2.9 | 1.2 | 13 | 8 | 0.0064 | 980 | 7 | NA | | | | |
| | | 1 | 160 | | | 6.6 | 16 | 0.0032 | 2000 | 16 | NA | | | | |
| Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a) | conifer forests, sugarcane, conifer (Christmas tree) farms, turf for sod in FL | 4 | 350 | 0.066 | 0.77 | 1.3 | 79 | 0.015 | 410 | 66 | 0.092 | 19 | 0.018 | 100 | 16 |
| | sugarcane | 2.6 | 350 | 0.066 | 0.77 | 0.86 | 120 | 0.01 | 620 | 100 | 0.06 | 30 | 0.012 | 150 | 25 |
| | chemical fallow | 3 | 1200 | 0.066 | 0.77 | 3.4 | 31 | 0.04 | 160 | 26 | 0.24 | 7.6 | 0.046 | 39 | 6.3 |
| | chemical fallow | 3 | 350 | 0.066 | 0.77 | 0.99 | 110 | 0.012 | 540 | 88 | 0.069 | 26 | 0.013 | 130 | 22 |
| | chemical fallow | 1.4 | 1200 | 0.066 | 0.77 | 1.6 | 66 | 0.018 | 340 | 55 | 0.11 | 16 | 0.022 | 83 | 14 |
| | chemical fallow | 1.4 | 350 | 0.066 | 0.77 | 0.46 | 230 | 0.0054 | 1200 | 190 | 0.032 | 56 | 0.0063 | 290 | 47 |
| | CRP/grasslands | 2 | 1200 | 0.066 | 0.77 | 2.3 | 46 | 0.026 | 240 | 38 | 0.16 | 11 | 0.031 | 58 | 9.5 |
| | CRP/grasslands | 2 | 350 | 0.066 | 0.77 | 0.66 | 160 | 0.0077 | 810 | 130 | 0.046 | 39 | 0.009 | 200 | 33 |
| | corn, sorghum | 2 | 1200 | 0.066 | 0.77 | 2.3 | 46 | 0.026 | 240 | 38 | 0.16 | 11 | 0.031 | 58 | 9.5 |
| | corn, sorghum | 2 | 350 | 0.066 | 0.77 | 0.66 | 160 | 0.0077 | 810 | 130 | 0.046 | 39 | 0.009 | 200 | 33 |
| | corn, sorghum | 1 | 1200 | 0.066 | 0.77 | 1.1 | 92 | 0.013 | 470 | 77 | 0.079 | 23 | 0.015 | 120 | 19 |
| | corn, sorghum | 1 | 350 | 0.066 | 0.77 | 0.33 | 320 | 0.0039 | 1600 | 260 | 0.023 | 78 | 0.0045 | 400 | 65 |
| | sod farms | 2 | 350 | 0.066 | 0.77 | 0.66 | 160 | 0.0077 | 810 | 130 | 0.046 | 39 | 0.009 | 200 | 33 |
| | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.066 | 0.77 | 0.3 | 340 | 0.0035 | 1800 | 290 | 0.021 | 85 | 0.0041 | 440 | 71 |
| Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b) | sugarcane | 2.6 | 80 | 0.066 | 0.77 | 0.2 | 530 | 0.0023 | 2700 | 440 | 0.014 | 130 | 0.0027 | 670 | 110 |
| | chemical fallow | 3 | 450 | 0.066 | 0.77 | 1.3 | 82 | 0.015 | 420 | 68 | 0.089 | 20 | 0.017 | 100 | 17 |
| | chemical fallow | 3 | 200 | 0.066 | 0.77 | 0.57 | 180 | 0.0066 | 950 | 150 | 0.04 | 45 | 0.0077 | 230 | 38 |
| | chemical fallow | 1.4 | 450 | 0.066 | 0.77 | 0.59 | 180 | 0.0069 | 900 | 150 | 0.042 | 43 | 0.0081 | 220 | 36 |
| | chemical fallow | 1.4 | 200 | 0.066 | 0.77 | 0.26 | 390 | 0.0031 | 2000 | 330 | 0.018 | 97 | 0.0036 | 500 | 82 |
| | CRP/grasslands | 2 | 450 | 0.066 | 0.77 | 0.85 | 120 | 0.0099 | 630 | 100 | 0.059 | 30 | 0.012 | 160 | 25 |

| Table 5: Atrazine: Short-term Baseline Handler Exposure and Risk Estimates | | | | | | | | | | | Intermediate-term Risk Estimates | | | | |
|---|---|---|---|---|--|--------------------------------|-------------------------------|------------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|------------------------------------|-----------------------------------|---|
| Exposure Scenario | Crop Type | Applica- tion Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer/ day (b) | Baseline Dermal Unit Exposure (mg/lb ai) (c) | Baseline Inhalation Unit Exposure (ug/lb ai) (d) | Baseline Dermal Dose (e) | Baseline Dermal MOE (f) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (f) | Baseline Aggregate MOE (f) | Baseline Dermal Dose (e) | Baseline Dermal MOE (g) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (h) | Aggregate MOE (Baseline Dermal + Inh) (h) |
| | CRP/grasslands | 2 | 200 | 0.066 | 0.77 | 0.38 | 280 | 0.0044 | 1400 | 230 | 0.026 | 68 | 0.0051 | 350 | 57 |
| | corn, sorghum | 2 | 450 | 0.066 | 0.77 | 0.85 | 120 | 0.0099 | 630 | 100 | 0.059 | 30 | 0.012 | 160 | 25 |
| | corn, sorghum | 2 | 200 | 0.066 | 0.77 | 0.38 | 280 | 0.0044 | 1400 | 230 | 0.026 | 68 | 0.0051 | 350 | 57 |
| | corn, sorghum | 1 | 450 | 0.066 | 0.77 | 0.42 | 250 | 0.005 | 1300 | 210 | 0.03 | 61 | 0.0058 | 310 | 51 |
| | corn, sorghum | 1 | 200 | 0.066 | 0.77 | 0.19 | 550 | 0.0022 | 2800 | 460 | 0.013 | 140 | 0.0026 | 700 | 110 |
| | roadsides | 1 | 40 | 0.066 | 0.77 | 0.038 | 2800 | 0.00044 | 14000 | 2300 | 0.0026 | 680 | 0.00051 | 3500 | 570 |
| | roadsides | 4 | 40 | 0.066 | 0.77 | 0.15 | 690 | 0.0018 | 3600 | 580 | 0.011 | 170 | 0.0021 | 880 | 140 |
| | golf course turf | 2 | 40 | 0.066 | 0.77 | 0.075 | 1400 | 0.00088 | 7100 | 1200 | 0.0053 | 340 | 0.001 | 1800 | 290 |
| | sod farms | 2 | 80 | 0.066 | 0.77 | 0.15 | 690 | 0.0018 | 3600 | 580 | 0.011 | 170 | 0.0021 | 880 | 140 |
| Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c) | roadsides | 1 | 40 | 0.066 | 0.77 | 0.038 | 2800 | 0.00044 | 14000 | 2300 | 0.0026 | 680 | 0.00051 | 3500 | 570 |
| | roadsides | 4 | 40 | 0.066 | 0.77 | 0.15 | 690 | 0.0018 | 3600 | 580 | 0.011 | 170 | 0.0021 | 880 | 140 |
| Loading Granular Formulations (3) | sod farms | 2 | 80 | 0.0084 | 1.7 | 0.019 | 5400 | 0.0039 | 1600 | 1200 | 0.0013 | 1300 | 0.0045 | 400 | 310 |
| | golf course turf | 2 | 40 | 0.0084 | 1.7 | 0.0096 | 11000 | 0.0019 | 3200 | 2500 | 0.00067 | 2700 | 0.0023 | 790 | 610 |
| Applicator | | | | | | | | | | | | | | | |
| Applying Liquids with Aircraft (4) | All Crops | | | See Engineering Controls | | | | | | | | | | | |
| Applying Liquids for Groundboom Application (5) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.014 | 0.74 | 0.064 | 1600 | 0.0034 | 1800 | 860 | 0.0045 | 400 | 0.0039 | 460 | 210 |
| | sugarcane | 2.6 | 80 | 0.014 | 0.74 | 0.042 | 2500 | 0.0022 | 2800 | 1300 | 0.0029 | 620 | 0.0026 | | 330 |
| | chemical fallow | 3 | 450 | 0.014 | 0.74 | 0.27 | 390 | 0.014 | 440 | 200 | 0.019 | 95 | 0.017 | 110 | 51 |
| | chemical fallow | 3 | 200 | 0.014 | 0.74 | 0.12 | 870 | 0.0063 | 990 | 460 | 0.0084 | 210 | 0.0074 | 240 | 110 |
| | chemical fallow | 1.4 | 450 | 0.014 | 0.74 | 0.13 | 830 | 0.0067 | 940 | 440 | 0.0088 | 200 | 0.0078 | 230 | 110 |
| | chemical fallow | 1.4 | 200 | 0.014 | 0.74 | 0.056 | 1900 | 0.003 | 2100 | 990 | 0.0039 | 460 | 0.0035 | 520 | 240 |
| | CRP/grasslands | 2 | 450 | 0.014 | 0.74 | 0.18 | 580 | 0.0095 | 660 | 310 | 0.013 | 140 | 0.011 | 160 | 76 |
| | CRP/grasslands | 2 | 200 | 0.014 | 0.74 | 0.08 | 1300 | 0.0042 | 1500 | 690 | 0.0056 | 320 | 0.0049 | 360 | 170 |
| | corn, sorghum | 2 | 450 | 0.014 | 0.74 | 0.18 | 580 | 0.0095 | 660 | 310 | 0.013 | 140 | 0.011 | 160 | 76 |
| | corn, sorghum | 2 | 200 | 0.014 | 0.74 | 0.08 | 1300 | 0.0042 | 1500 | 690 | 0.0056 | 320 | 0.0049 | 360 | 170 |
| | corn, sorghum | 1 | 450 | 0.014 | 0.74 | 0.09 | 1200 | 0.0048 | 1300 | 610 | 0.0063 | 290 | 0.0056 | 320 | 150 |
| | corn, sorghum | 1 | 200 | 0.014 | 0.74 | 0.04 | 2600 | 0.0021 | 3000 | 1400 | 0.0028 | 640 | 0.0025 | 730 | 340 |
| | roadsides | 4 | 40 | 0.014 | 0.74 | 0.032 | 3300 | 0.0017 | 3700 | 1700 | 0.0022 | 800 | 0.002 | 910 | 430 |
| | roadsides | 1 | 40 | 0.014 | 0.74 | 0.008 | 13000 | 0.00042 | 15000 | 6900 | 0.00056 | 3200 | 0.00049 | 3600 | 1700 |
| | golf course turf | 2 | 40 | 0.014 | 0.74 | 0.016 | 6500 | 0.00085 | 7400 | 3500 | 0.0011 | 1600 | 0.00099 | 1800 | 850 |
| | sod farms, conifer (Christmas tree) farms | 2 | 80 | 0.014 | 0.74 | 0.032 | 3300 | 0.0017 | 3700 | 1700 | 0.0022 | 800 | 0.002 | 910 | 430 |
| Applying Liquids with a Rights-of-Way Sprayer (6) | roadsides | 4 | 40 | 1.3 | 3.9 | 3 | 35 | 0.0089 | 700 | 33 | 0.21 | 8.7 | 0.01 | 170 | 8.2 |
| | roadsides | 1 | 40 | 1.3 | 3.9 | 0.74 | 140 | 0.0022 | 2800 | 130 | 0.052 | 35 | 0.0026 | 690 | 33 |
| Applying Liquids with a Handgun (7) (ORETF) | lawns, golf courses | 2 | 5 | see PPE | 1.0 | ND | ND | 0.00014 | 44,000 | NA | ND | ND | 0.00023 | 11,000 | 7800 |

| Table 5: Atrazine: Short-term Baseline Handler Exposure and Risk Estimates | | | | | | | | | | | Intermediate-term Risk Estimates | | | | |
|--|--------------------------------------|---|---|---|--|--------------------------------|-------------------------------|------------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|------------------------------------|-----------------------------------|---|
| Exposure Scenario | Crop Type | Applica- tion Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer/ day (b) | Baseline Dermal Unit Exposure (mg/lb ai) (c) | Baseline Inhalation Unit Exposure (ug/lb ai) (d) | Baseline Dermal Dose (e) | Baseline Dermal MOE (f) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (f) | Baseline Aggregate MOE (f) | Baseline Dermal Dose (e) | Baseline Dermal MOE (g) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (h) | Aggregate MOE (Baseline Dermal + Inh) (h) |
| Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader (8) | corn, sorghum | 2 | 320 | 0.0099 | 1.2 | 0.091 | 1100 | 0.013 | 480 | 340 | NA | | | | |
| | | | 160 | | | 0.045 | 2300 | 0.0064 | 980 | 680 | NA | | | | |
| | | 1 | 320 | | | 0.045 | 2300 | 0.0064 | 980 | 680 | NA | | | | |
| | | | 160 | | | 0.023 | 4500 | 0.0032 | 2000 | 1300 | NA | | | | |
| Applying Granular with a Tractor Drawn Spreader (9) | on farm fertilizer for corn, sorghum | 2 | 200 | 0.0099 | 1.2 | 0.057 | 1800 | 0.0069 | 910 | 610 | 0.004 | 450 | 0.008 | 230 | 150 |
| | | | 80 | 0.0099 | 1.2 | 0.023 | 4600 | 0.0027 | 2300 | 1500 | 0.0016 | 1100 | 0.0032 | 560 | 380 |
| | | 1 | 200 | 0.0099 | 1.2 | 0.028 | 3700 | 0.0034 | 1800 | 1200 | 0.002 | 910 | 0.004 | 450 | 300 |
| | | | 80 | 0.0099 | 1.2 | 0.011 | 9200 | 0.0014 | 4600 | 3000 | 0.00079 | 2300 | 0.0016 | 1100 | 750 |
| | golf course turf | 2 | 40 | 0.0099 | 1.2 | 0.011 | 9200 | 0.0014 | 4600 | 3000 | 0.00079 | 2300 | 0.0016 | 1100 | 750 |
| Mixer/Loader/Applicator | | | | | | | | | | | | | | | |
| Backpack Sprayer (LCO) (10) | lawns, golf courses | 2 | 5 | See PPE | 30 | | | 0.0043 | 1500 | | | | 0.005 | 360 | |
| Low Pressure Handwand - Liquid Formulations (LCO) (11) | lawns, golf courses | 2 | 5 | 100 | 30 | 14 | 7.3 | 0.0043 | 1500 | 7.2 | 1 | 1.8 | 0.005 | 360 | 1.8 |
| Lawn Handgun (and Compressed Air Sprayer) (all formulations, ORETF data) (LCO) (12) | lawns, golf courses | 2 | 5 | see PPE | see PPE | ND | ND | ND | ND | ND | see PPE | ND | ND | ND | ND |
| Granulars with a Push Type Spreader (LCO) ORETF Data (13) | lawns, golf courses | 2 | 5 | 0.31 | 6.3 | 0.044 | 2300 | 0.0009 | 6900 | 1800 | 0.029 | 62 | 0.0011 | 1700 | 60 |
| Granulars with a Bellygrinder (LCO) (14) | lawns, golf courses | 2 | 1 | 10 | 62 | 0.29 | 360 | 0.0018 | 3500 | 330 | 0.02 | 90 | 0.0021 | 870 | 82 |

| Table 5: Atrazine: Short-term Baseline Handler Exposure and Risk Estimates | | | | | | | | | | | Intermediate-term Risk Estimates | | | | |
|--|---|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|----------------------------|----------------------------------|-------------------------|------------------------------|-----------------------------|---|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | Baseline Dermal Unit Exposure (mg/lb ai) (c) | Baseline Inhalation Unit Exposure (ug/lb ai) (d) | Baseline Dermal Dose (e) | Baseline Dermal MOE (f) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (f) | Baseline Aggregate MOE (f) | Baseline Dermal Dose (e) | Baseline Dermal MOE (g) | Baseline Inhalation Dose (e) | Baseline Inhalation MOE (h) | Aggregate MOE (Baseline Dermal + Inh) (h) |
| Flagging | | | | | | | | | | | | | | | |
| Flagging Sprays (15) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms | 4 | 350 | 0.011 | 0.35 | 0.22 | 470 | 0.007 | 890 | 310 | 0.015 | 120 | 0.0082 | 220 | 76 |
| | sugarcane | 2.6 | 350 | 0.011 | 0.35 | 0.14 | 730 | 0.0046 | 1400 | 480 | 0.01 | 180 | 0.0053 | 340 | 120 |
| | chemical fallow | 3 | 1200 | 0.011 | 0.35 | 0.57 | 180 | 0.018 | 350 | 120 | 0.04 | 45 | 0.021 | 86 | 30 |
| | chemical fallow | 3 | 350 | 0.011 | 0.35 | 0.17 | 630 | 0.0053 | 1200 | 410 | 0.012 | 160 | 0.0061 | 290 | 100 |
| | chemical fallow | 1.4 | 1200 | 0.011 | 0.35 | 0.26 | 390 | 0.0084 | 740 | 260 | 0.018 | 97 | 0.0098 | 180 | 64 |
| | chemical fallow | 1.4 | 350 | 0.011 | 0.35 | 0.077 | 1400 | 0.0025 | 2600 | 880 | 0.0054 | 330 | 0.0029 | 630 | 220 |
| | CRP/grasslands | 2 | 1200 | 0.011 | 0.35 | 0.38 | 280 | 0.012 | 520 | 180 | 0.026 | 68 | 0.014 | 130 | 45 |
| | CRP/grasslands | 2 | 350 | 0.011 | 0.35 | 0.11 | 950 | 0.0035 | 1800 | 620 | 0.0077 | 230 | 0.0041 | 440 | 150 |
| | corn, sorghum | 2 | 1200 | 0.011 | 0.35 | 0.38 | 280 | 0.012 | 520 | 180 | 0.026 | 68 | 0.014 | 130 | 45 |
| | corn, sorghum | 2 | 350 | 0.011 | 0.35 | 0.11 | 950 | 0.0035 | 1800 | 620 | 0.0077 | 230 | 0.0041 | 440 | 150 |
| | corn, sorghum | 1 | 1200 | 0.011 | 0.35 | 0.19 | 550 | 0.006 | 1000 | 360 | 0.013 | 140 | 0.007 | 260 | 89 |
| | corn, sorghum | 1 | 350 | 0.011 | 0.35 | 0.055 | 1900 | 0.0018 | 3600 | 1200 | 0.0039 | 470 | 0.002 | 880 | 310 |
| | sod farms | 2 | 350 | 0.011 | 0.35 | 0.11 | 950 | 0.0035 | 1800 | 620 | 0.0077 | 230 | 0.0041 | 440 | 150 |

Footnotes:

- a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).
- b Amount handled per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.
- Fertilizer: For commercial bulk fertilizer admixture: If two pounds atrazine active ingredient per acre is impregnated onto 400 pounds of fertilizer (for the 400 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 10 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 400 pounds of fertilizer per acre rate is (960)(10) = 9600 pounds of atrazine active ingredient handled per day. Using the registrant-supplied upper limit of production, only 500 tons are produced, so (500)(10) = 5000 pounds of atrazine handled per day.
- PHED liquid mixer/loader data for closed system. Arithmetic mean of operator exposure data from Helix (TM) Canadian seed treatment study submitted by Syngenta.
- Application: 320 A/day estimated for 20-ton commercial truck spreader; 160 A/day reasonable max for 10-ton truck or on-farm equipment.
- c Baseline dermal unit exposure represents long pants, long sleeved shirt, no gloves, open mixing/loading, open cab/tractor. Values from PHED Surrogate Exposure Guide - August, 1998; except scenarios 12 & 13 based on Outdoor Residential Exposure Task Force studies (MRID 449722-01; ORETF Study Number OMA001 and OMA002).
- d Baseline inhalation unit exposure represents no respirator. PHED Surrogate Exposure Guide - August 1998.; except scenarios 7, 12 & 13 based on Outdoor Residential Exposure Task Force studies (MRID 449722-01; ORETF Study Number OMA001 and OMA002).
- e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x area treated per day (acres/day) / body weight (70 kg adults for short-term and 60 kg adult female --developmental effect -- for intermediate-term assessment). For intermediate-term dermal dose an absorption factor of 6 percent applies.
- Inhalation daily dose (mg/kg/day) = inhalation unit exposure (ug/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 ug) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).
- f Short-term dermal MOE = NOAEL (104 mg/kg/day) / daily dose (mg/kg/day).
- Short-term inhalation MOE = NOAEL (6.25 mg/kg/day) / daily dose (mg/kg/day).
- Combined dermal & inhalation MOE calculated: MOE [total] = 1 / [(1/MOEdermal) + (1/MOEinhalation)].
- g Intermediate-term dermal MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).
- h Intermediate-term inhalation MOE = NOAEL (1.8 mg/kg/day) / daily dose (mg/kg/day).
- Combined MOE = NOAEL (1.8 mg/kg/day) / absorbed daily dermal + inhalation dose (mg/kg/day)
- See PPE = no data at baseline, see exposures and risks with personal protective equipment (Table 6)
- See Engineering Controls = no data at baseline or PPE, see exposures and risks with engineering controls (Table 7)
- CRP = Conservation Reserve Program

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|---|---|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL,Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| Mixer/Loader | | | | | | | | | | | | | | | | | |
| Mixing/ Loading Liquid Formulations for Aerial Application (1a) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL | 4 | 350 | 0.023 | 0.017 | 0.24 | 0.46 | 230 | 0.34 | 310 | 4.8e-03 | 122 | 1300 | 248 | 61 | 30 | 35 |
| | sugarcane | 2.6 | 350 | 0.023 | 0.017 | 0.24 | 0.3 | 350 | 0.22 | 470 | 3.1e-03 | 187 | 2000 | 381 | 94 | 46 | 53 |
| | chemical fallow | 3 | 1200 | 0.023 | 0.017 | 0.24 | 1.2 | 88 | 0.87 | 120 | 1.2e-02 | 47 | 510 | 96 | NA | NA | NA |
| | chemical fallow | 3 | 350 | 0.023 | 0.017 | 0.24 | 0.35 | 300 | 0.26 | 410 | 3.6e-03 | 161 | 1700 | 330 | 82 | 40 | 46 |
| | chemical fallow | 1.4 | 1200 | 0.023 | 0.017 | 0.24 | 0.55 | 190 | 0.41 | 250 | 5.8e-03 | 101 | 1100 | 206 | NA | NA | NA |
| | chemical fallow | 1.4 | 350 | 0.023 | 0.017 | 0.24 | 0.16 | 650 | 0.12 | 870 | 1.7e-03 | 347 | 3700 | 708 | 170 | 85 | 99 |
| | CRP/grasslands | 2 | 1200 | 0.023 | 0.017 | 0.24 | 0.79 | 130 | 0.58 | 180 | 8.2e-03 | 70 | 760 | 144 | NA | NA | NA |
| | CRP/grasslands | 2 | 350 | 0.023 | 0.017 | 0.24 | 0.23 | 450 | 0.17 | 610 | 2.4e-03 | 241 | 2600 | 495 | 120 | 60 | 69 |
| | corn, sorghum | 2 | 1200 | 0.023 | 0.017 | 0.24 | 0.79 | 130 | 0.58 | 180 | 8.2e-03 | 70 | 760 | 144 | NA | NA | NA |
| | corn, sorghum | 2 | 350 | 0.023 | 0.017 | 0.24 | 0.23 | 450 | 0.17 | 610 | 2.4e-03 | 241 | 2600 | 495 | 120 | 60 | 69 |
| | corn, sorghum | 1 | 1200 | 0.023 | 0.017 | 0.24 | 0.39 | 260 | 0.29 | 360 | 4.1e-03 | 140 | 1500 | 289 | NA | NA | NA |
| | corn, sorghum | 1 | 350 | 0.023 | 0.017 | 0.24 | 0.12 | 900 | 0.085 | 1200 | 1.2e-03 | 483 | 5200 | 991 | 240 | 120 | 140 |
| | sod farms | 2 | 350 | 0.023 | 0.017 | 0.24 | 0.23 | 450 | 0.17 | 610 | 2.4e-03 | 241 | 2600 | 495 | 120 | 60 | 69 |

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|---|--|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL, Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| Mixing/ Loading Liquid Formulations for Ground boom Application (1b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.023 | 0.017 | 0.24 | 0.11 | 990 | 0.078 | 1300 | 1.1e-03 | 530 | 5700 | 1084 | 270 | 130 | 150 |
| | sugarcane | 2.6 | 80 | 0.023 | 0.017 | 0.24 | 0.068 | 1500 | 0.051 | 2100 | 7.1e-04 | 808 | 8800 | 1667 | 410 | 200 | 230 |
| | chemical fallow | 3 | 450 | 0.023 | 0.017 | 0.24 | 0.44 | 230 | 0.33 | 320 | 4.6e-03 | 124 | 1400 | 257 | 63 | 31 | 36 |
| | chemical fallow | 3 | 200 | 0.023 | 0.017 | 0.24 | 0.2 | 530 | 0.15 | 710 | 2.1e-03 | 283 | 3000 | 578 | 140 | 70 | 81 |
| | chemical fallow | 1.4 | 450 | 0.023 | 0.017 | 0.24 | 0.21 | 500 | 0.15 | 680 | 2.2e-03 | 268 | 2900 | 550 | 140 | 66 | 77 |
| | chemical fallow | 1.4 | 200 | 0.023 | 0.017 | 0.24 | 0.092 | 1100 | 0.068 | 1500 | 9.6e-04 | 596 | 6500 | 1238 | 310 | 150 | 170 |
| | CRP/grasslands | 2 | 450 | 0.023 | 0.017 | 0.24 | 0.3 | 350 | 0.22 | 480 | 3.1e-03 | 188 | 2000 | 385 | 95 | 47 | 54 |
| | CRP/grasslands | 2 | 200 | 0.023 | 0.017 | 0.24 | 0.13 | 790 | 0.097 | 1100 | 1.4e-03 | 423 | 4600 | 867 | 210 | 100 | 120 |
| | corn, sorghum | 2 | 450 | 0.023 | 0.017 | 0.24 | 0.3 | 350 | 0.22 | 480 | 3.1e-03 | 188 | 2000 | 385 | 95 | 47 | 54 |
| | corn, sorghum | 2 | 200 | 0.023 | 0.017 | 0.24 | 0.13 | 790 | 0.097 | 1100 | 1.4e-03 | 423 | 4600 | 867 | 210 | 100 | 120 |
| | corn, sorghum | 1 | 450 | 0.023 | 0.017 | 0.24 | 0.15 | 700 | 0.11 | 950 | 1.5e-03 | 376 | 4100 | 771 | 190 | 93 | 110 |
| | corn, sorghum | 1 | 200 | 0.023 | 0.017 | 0.24 | 0.066 | 1600 | 0.049 | 2100 | 6.9e-04 | 852 | 9100 | 1734 | 430 | 210 | 240 |
| | roadsides | 1 | 40 | 0.023 | 0.017 | 0.24 | 0.013 | 7900 | 0.0097 | 11000 | 1.4e-04 | 4232 | 46000 | 8669 | 2100 | 1000 | 1200 |
| | bermuda grass rights of way | 4 | 40 | 0.023 | 0.017 | 0.24 | 0.053 | 2000 | 0.039 | 2700 | 5.5e-04 | 1065 | 11000 | 2167 | 540 | 260 | 300 |
| | golf course turf | 2 | 40 | 0.023 | 0.017 | 0.24 | 0.026 | 4000 | 0.019 | 5400 | 2.7e-04 | 2130 | 23000 | 4335 | 1100 | 520 | 610 |
| | sod farms | 2 | 80 | 0.023 | 0.017 | 0.24 | 0.053 | 2000 | 0.039 | 2700 | 5.5e-04 | 1065 | 11000 | 2167 | 540 | 260 | 300 |
| Mixing/ Loading Liquid Formulations for Rights-of-Way Sprayer (1c) | roadsides | 1 | 40 | 0.023 | 0.017 | 0.24 | 0.013 | 7900 | 0.0097 | 11000 | 1.4e-04 | 4232 | 46000 | 8669 | 2100 | 1000 | 1200 |
| | bermuda grass rights of way | 4 | 40 | 0.023 | 0.017 | 0.24 | 0.053 | 2000 | 0.039 | 2700 | 5.5e-04 | 1065 | 11000 | 2167 | 540 | 260 | 300 |

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|--|---|---|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL,Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d) | lawns, golf courses | 2 | 100 | 0.023 | 0.017 | 0.24 | 0.066 | 1600 | 0.049 | 2100 | 6.9e-04 | 852 | 9100 | 1734 | 430 | 210 | 240 |
| Mixing/Loading/Incorporating Liquid Formulations onto Liquid or Dry Bulk Fertilizer (1e) | commercial fertilizer for corn, sorghum: *PHED data | 2 | 960 tons | | | See Engineering Controls | | | | | | | | | See Engineering Controls | | |
| | | | 500 tons | | | See Engineering Controls | | | | | | | | | | | |
| | *Helix study data | | 500 tons | | | See Engineering Controls | | | | | | | | | | | |
| | commercial fertilizer for corn, sorghum: *PHED data | 1 | 960 tons | | | See Engineering Controls | | | | | | | | | | | |
| | | | 500 tons | | | See Engineering Controls | | | | | | | | | | | |
| | *Helix study data | | 500 tons | | | See Engineering Controls | | | | | | | | | | | |
| | on-farm fertilizer for corn, sorghum | 2 | 160 | 0.023 | 0.017 | 0.24 | 0.11 | 990 | 0.078 | 1300 | 1.1e-03 | 500 | 5600 | 1100 | NA | NA | NA |
| | | 1 | 160 | | | 0.24 | 0.55 | 1,900 | 0.039 | 2700 | 5.5e-04 | 250 | 11000 | 2200 | NA | NA | NA |
| | | | | | | | | | | | | | | | | | |
| Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a) | conifer forest, sugarcane, conifer (Christmas tree) farms, turf for sod in FL | 4 | 350 | 0.066 | 0.047 | 0.154 | 1.3 | 79 | 0.94 | 110 | 3.1e-03 | 66 | 2000 | 105 | 26 | 16 | 21 |
| | sugarcane | 2.6 | 350 | 0.066 | 0.047 | 0.154 | 0.86 | 120 | 0.61 | 170 | 2.0e-03 | 101 | 3100 | 161 | 40 | 25 | 33 |
| | chemical fallow | 3 | 1200 | 0.066 | 0.047 | 0.154 | 3.4 | 31 | 2.4 | 43 | 7.9e-03 | 26 | 790 | 41 | NA | NA | NA |
| | chemical fallow | 3 | 350 | 0.066 | 0.047 | 0.154 | 0.99 | 110 | 0.71 | 150 | 2.3e-03 | 91 | 2700 | 140 | 35 | 22 | 29 |
| | chemical fallow | 1.4 | 1200 | 0.066 | 0.047 | 0.154 | 1.6 | 66 | 1.1 | 92 | 3.7e-03 | 55 | 1700 | 87 | NA | NA | NA |
| | chemical fallow | 1.4 | 350 | 0.066 | 0.047 | 0.154 | 0.46 | 230 | 0.33 | 320 | 1.1e-03 | 192 | 5800 | 300 | 74 | 47 | 61 |
| | CRP/grasslands | 2 | 1200 | 0.066 | 0.047 | 0.154 | 2.3 | 46 | 1.6 | 65 | 5.3e-03 | 39 | 1200 | 61 | NA | NA | NA |
| | CRP/grasslands | 2 | 350 | 0.066 | 0.047 | 0.154 | 0.66 | 160 | 0.47 | 220 | 1.5e-03 | 134 | 4100 | 210 | 52 | 33 | 43 |
| | corn, sorghum | 2 | 1200 | 0.066 | 0.047 | 0.154 | 2.3 | 46 | 1.6 | 65 | 5.3e-03 | 39 | 1200 | 61 | NA | NA | NA |
| | corn, sorghum | 2 | 350 | 0.066 | 0.047 | 0.154 | 0.66 | 160 | 0.47 | 220 | 1.5e-03 | 134 | 4100 | 210 | 52 | 33 | 43 |
| | corn, sorghum | 1 | 1200 | 0.066 | 0.047 | 0.154 | 1.1 | 92 | 0.81 | 130 | 2.6e-03 | 77 | 2400 | 122 | NA | NA | NA |
| | corn, sorghum | 1 | 350 | 0.066 | 0.047 | 0.154 | 0.33 | 320 | 0.24 | 440 | 7.7e-04 | 267 | 8100 | 420 | 100 | 65 | 86 |
| | sod farms | 2 | 350 | 0.066 | 0.047 | 0.154 | 0.66 | 160 | 0.47 | 220 | 1.5e-03 | 134 | 4100 | 210 | 52 | 33 | 43 |
| | | | | | | | | | | | | | | | | | |

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|--|--|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL, Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.066 | 0.047 | 0.154 | 0.3 | 340 | 0.21 | 480 | 7.0e-04 | 285 | 8900 | 459 | 110 | 71 | 94 |
| | sugarcane | 2.6 | 80 | 0.066 | 0.047 | 0.154 | 0.2 | 530 | 0.14 | 740 | 4.6e-04 | 444 | 14000 | 706 | 170 | 110 | 140 |
| | chemical fallow | 3 | 450 | 0.066 | 0.047 | 0.154 | 1.3 | 82 | 0.91 | 110 | 3.0e-03 | 69 | 2100 | 109 | 27 | 17 | 22 |
| | chemical fallow | 3 | 200 | 0.066 | 0.047 | 0.154 | 0.57 | 180 | 0.4 | 260 | 1.3e-03 | 151 | 4700 | 245 | 61 | 38 | 50 |
| | chemical fallow | 1.4 | 450 | 0.066 | 0.047 | 0.154 | 0.59 | 180 | 0.42 | 250 | 1.4e-03 | 150 | 4500 | 233 | 58 | 36 | 48 |
| | chemical fallow | 1.4 | 200 | 0.066 | 0.047 | 0.154 | 0.26 | 390 | 0.19 | 550 | 6.2e-04 | 327 | 10000 | 525 | 130 | 82 | 110 |
| | CRP/grasslands | 2 | 450 | 0.066 | 0.047 | 0.154 | 0.85 | 120 | 0.6 | 170 | 2.0e-03 | 101 | 3200 | 163 | 40 | 25 | 33 |
| | CRP/grasslands | 2 | 200 | 0.066 | 0.047 | 0.154 | 0.38 | 280 | 0.27 | 390 | 8.8e-04 | 234 | 7100 | 367 | 91 | 57 | 75 |
| | corn, sorghum | 2 | 450 | 0.066 | 0.047 | 0.154 | 0.85 | 120 | 0.6 | 170 | 2.0e-03 | 101 | 3200 | 163 | 40 | 25 | 33 |
| | corn, sorghum | 2 | 200 | 0.066 | 0.047 | 0.154 | 0.38 | 280 | 0.27 | 390 | 8.8e-04 | 234 | 7100 | 367 | 91 | 57 | 75 |
| | corn, sorghum | 1 | 450 | 0.066 | 0.047 | 0.154 | 0.42 | 250 | 0.3 | 340 | 9.9e-04 | 209 | 6300 | 326 | 81 | 51 | 67 |
| | corn, sorghum | 1 | 200 | 0.066 | 0.047 | 0.154 | 0.19 | 550 | 0.13 | 770 | 4.4e-04 | 461 | 14000 | 734 | 180 | 110 | 150 |
| | roadsides | 1 | 40 | 0.066 | 0.047 | 0.154 | 0.038 | 2800 | 0.027 | 3900 | 8.8e-05 | 2339 | 71000 | 3672 | 910 | 570 | 750 |
| | roadsides | 4 | 40 | 0.066 | 0.047 | 0.154 | 0.15 | 690 | 0.11 | 970 | 3.5e-04 | 578 | 18000 | 918 | 230 | 140 | 190 |
| | golf course turf | 2 | 40 | 0.066 | 0.047 | 0.154 | 0.075 | 1400 | 0.054 | 1900 | 1.8e-04 | 1169 | 36000 | 1836 | 450 | 290 | 380 |
| | sod farms | 2 | 80 | 0.066 | 0.047 | 0.154 | 0.15 | 690 | 0.11 | 970 | 3.5e-04 | 578 | 18000 | 918 | 230 | 140 | 190 |
| Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c) | roadsides | 1 | 40 | 0.066 | 0.047 | 0.154 | 0.038 | 2800 | 0.027 | 3900 | 8.8e-05 | 2339 | 71000 | 3672 | 910 | 570 | 750 |
| | roadsides | 4 | 40 | 0.066 | 0.047 | 0.154 | 0.15 | 690 | 0.11 | 970 | 3.5e-04 | 578 | 18000 | 918 | 230 | 140 | 190 |
| Loading Granular Formulations (3) | sod farms | 2 | 80 | 0.0069 | 0.0034 | 0.34 | 0.016 | 6600 | 0.0078 | 13,000 | 7.8e-04 | 1293 | 8000 | 5023 | 1200 | 320 | 350 |
| | golf course turf | 2 | 40 | 0.0069 | 0.0034 | 0.34 | 0.0079 | 13000 | 0.0039 | 27000 | 3.9e-04 | 2579 | 16000 | 10047 | 2500 | 640 | 710 |

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|---|--|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL,Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| Applicator | | | | | | | | | | | | | | | | | |
| Applying Liquids with Aircraft (4) | All Crops | | | See Engineering Controls | | | | | | | | | | | | | |
| Applying Liquids for Groundboom Application (5) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.014 | 0.011 | 0.148 | 0.064 | 1600 | 0.05 | 2100 | 6.8e-04 | 857 | 9200 | 1690 | 420 | 210 | 240 |
| | sugarcane | 2.6 | 80 | 0.014 | 0.011 | 0.148 | 0.042 | 2500 | 0.033 | 3200 | 4.4e-04 | 1330 | 14000 | 2600 | 640 | 330 | 370 |
| | chemical fallow | 3 | 450 | 0.014 | 0.011 | 0.148 | 0.27 | 390 | 0.21 | 490 | 2.9e-03 | 206 | 2200 | 401 | 99 | 51 | 57 |
| | chemical fallow | 3 | 200 | 0.014 | 0.011 | 0.148 | 0.12 | 870 | 0.094 | 1100 | 1.3e-03 | 462 | 4900 | 901 | 220 | 110 | 130 |
| | chemical fallow | 1.4 | 450 | 0.014 | 0.011 | 0.148 | 0.13 | 830 | 0.099 | 1100 | 1.3e-03 | 440 | 4700 | 858 | 210 | 110 | 120 |
| | chemical fallow | 1.4 | 200 | 0.014 | 0.011 | 0.148 | 0.056 | 1900 | 0.044 | 2400 | 5.9e-04 | 1000 | 11000 | 1931 | 480 | 240 | 280 |
| | CRP/grasslands | 2 | 450 | 0.014 | 0.011 | 0.148 | 0.18 | 580 | 0.14 | 740 | 1.9e-03 | 308 | 3300 | 601 | 150 | 76 | 86 |
| | CRP/grasslands | 2 | 200 | 0.014 | 0.011 | 0.148 | 0.08 | 1300 | 0.063 | 1700 | 8.5e-04 | 692 | 7400 | 1352 | 330 | 170 | 190 |
| | corn, sorghum | 2 | 450 | 0.014 | 0.011 | 0.148 | 0.18 | 580 | 0.14 | 740 | 1.9e-03 | 308 | 3300 | 601 | 150 | 76 | 86 |
| | corn, sorghum | 2 | 200 | 0.014 | 0.011 | 0.148 | 0.08 | 1300 | 0.063 | 1700 | 8.5e-04 | 692 | 7400 | 1352 | 330 | 170 | 190 |
| | corn, sorghum | 1 | 450 | 0.014 | 0.011 | 0.148 | 0.09 | 1200 | 0.071 | 1500 | 9.5e-04 | 627 | 6600 | 1202 | 300 | 150 | 170 |
| | corn, sorghum | 1 | 200 | 0.014 | 0.011 | 0.148 | 0.04 | 2600 | 0.031 | 3300 | 4.2e-04 | 1383 | 15000 | 2704 | 670 | 340 | 390 |
| | roadsides | 4 | 40 | 0.014 | 0.011 | 0.148 | 0.032 | 3300 | 0.025 | 4100 | 3.4e-04 | 1743 | 18000 | 3380 | 840 | 430 | 480 |
| | roadsides | 1 | 40 | 0.014 | 0.011 | 0.148 | 0.008 | 13000 | 0.0063 | 17000 | 8.5e-05 | 6917 | 74000 | 13519 | 3300 | 1700 | 1900 |
| | golf course turf | 2 | 40 | 0.014 | 0.011 | 0.148 | 0.016 | 6500 | 0.013 | 8300 | 1.7e-04 | 3458 | 37000 | 6759 | 1700 | 850 | 960 |
| | sod farms, conifer (Christmas tree) farms | 2 | 80 | 0.014 | 0.011 | 0.148 | 0.032 | 3300 | 0.025 | 4100 | 3.4e-04 | 1743 | 18000 | 3380 | 840 | 430 | 480 |
| Applying Liquids with a Rights-of-Way Sprayer (6) | roadsides | 4 | 40 | 0.39 | 0.29 | 0.78 | 0.89 | 120 | 0.66 | 160 | 1.8e-03 | 102 | 3500 | 150 | 37 | 25 | 32 |
| | roadsides | 1 | 40 | 0.39 | 0.29 | 0.78 | 0.22 | 470 | 0.17 | 630 | 4.5e-04 | 403 | 14000 | 601 | 150 | 99 | 130 |
| Applying Liquids with a Handgun (7) | lawns, golf courses | 2 | 5 | 0.73 | 0.4 | 0.2 | 0.10 | 1000 | 0.057 | 1800 | 2.9e-05 | 980 | 22,000 | 1800 | 450 | 240 | 430 |

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|---|---------------------------|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL, Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader(8) | corn, sorghum: commercial | 2 | 320 | 0.0072 | 0.0042 | 0.24 | 0.066 | 1600 | 0.038 | 1700 | 2.2e-03 | 420 | 2800 | 1400 | 340 | 100 | 120 |
| | private on-farm | | 160 | 0.0072 | 0.0042 | 0.24 | 0.033 | 3200 | 0.019 | 5400 | 1.1e-02 | 840 | 5700 | 2800 | NA | NA | NA |
| | commercial | 1 | 320 | 0.0072 | 0.0042 | 0.24 | 0.033 | 3200 | 0.019 | 5400 | 1.1e-02 | 840 | 5700 | 2800 | 690 | 210 | 230 |
| | private on-farm | | 160 | 0.0072 | 0.0042 | 0.24 | 0.016 | 6300 | 0.0096 | 11,000 | 5.5e-04 | 1700 | 11,000 | 5600 | NA | NA | NA |
| Applying Granular with a Tractor Drawn Spreader (9) | corn, sorghum | 2 | 200 | 0.0072 | 0.0042 | 0.24 | 0.041 | 2500 | 0.024 | 4300 | 1.4e-03 | 668 | 4600 | 2221 | 550 | 170 | 190 |
| | | 2 | 80 | 0.0072 | 0.0042 | 0.24 | 0.016 | 6300 | 0.0096 | 11000 | 5.5e-04 | 1673 | 11000 | 5553 | 1400 | 410 | 460 |
| | | 1 | 200 | 0.0072 | 0.0042 | 0.24 | 0.021 | 5100 | 0.012 | 8700 | 6.9e-04 | 1343 | 9100 | 4442 | 1100 | 330 | 370 |
| | | 1 | 80 | 0.0072 | 0.0042 | 0.24 | 0.0082 | 13000 | 0.0048 | 22000 | 2.7e-04 | 3374 | 23000 | 11106 | 2700 | 830 | 930 |
| | golf course turf | 2 | 40 | 0.0072 | 0.0042 | 0.24 | 0.0082 | 13000 | 0.0048 | 22000 | 2.7e-04 | 3374 | 23000 | 11106 | 2700 | 830 | 930 |
| Mixer/Loader/Applicator | | | | | | | | | | | | | | | | | |
| Backpack Sprayer (PCO) (10) | lawns, golf courses | 2 | 5 | 2.5 | 1.6 | 6 | 0.36 | 290 | 0.23 | 460 | 8.6e-04 | 242 | 7300 | 428 | 110 | 60 | 86 |
| Low Pressure Handwand - Liquid Formulations (LCO) (11) | lawns, golf courses | 2 | 5 | 0.73 | 0.4 | 0.2 | 0.01 | 1000 | 0.057 | 1800 | 2.9e-05 | 270 | 220,00 | 1800 | 450 | 240 | 430 |
| Lawn Handgun (LCO) ORETF data: (12a) liquid formulae (12b) WDG formulae (12c) WP in WSB | lawns, golf courses | 2 | 5 | 0.5 | 0.27 | 0.38 | 0.071 | 1500 | 0.039 | 2700 | NN | 1400 | NN | NN | NN | 340 | NN |
| | | | | 0.59 | 0.28 | 0.44 | 0.084 | 1200 | 0.040 | 2600 | NN | 1100 | NN | NN | NN | 290 | NN |
| | | | | 0.65 | 0.36 | 1.54 | 0.093 | 1100 | 0.051 | 2000 | NN | 920 | NN | NN | NN | 230 | NN |
| Granulars | lawns, golf | 2 | 5 | 0.22 | NN | NN | 0.031 | 3300 | NN | NN | NN | 2100 | NN | NN | NN | 520 | NN |

| Table 6: Atrazine Handler Short-term Exposure and Risk Estimates with PPE | | | | | | | | | | | | | | | Intermediate-term Risk Estimates | | |
|---|---|--|--|--|--|--|--------------------------|-------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------------|---------------------------------------|--------------------------------------|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | PPE (gl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (gl, dl) Dermal Unit Exposure (mg/lb ai) (c) | PPE (resp) Inhalation Unit Exposure (ug/lb ai) (d) | PPE (gl) Dermal Dose (e) | PPE (gl) Dermal MOE (f) | PPE (gl, dl) Dermal Dose (e) | PPE (gl, dl) Dermal MOE (f) | PPE (resp) Inhalation Dose (e) | PPE (Gloves) Aggregate MOE (f) | PPE (resp) Inhalation MOE (f) | PPE (DL, Gl, Resp) Aggregate MOE (f) | Aggregate MOE (PPE (gl, dl +resp) (f) | Aggregate MOE (PPE (gl, no resp) (f) | Aggregate MOE (PPE (gl, dl, no resp) (f) |
| with a Push Type Spreader (PCO) (13) (ORETF) | courses | | | | | | | | | | | | | | | | |
| Granulars with a Bellygrinder (PCO) (14) | lawns, golf courses | 2 | 1 | 9.3 | 5.7 | 12.4 | 0.27 | 390 | 0.16 | 640 | 3.5e-04 | 350 | 18000 | 616 | 150 | 87 | 130 |
| Flagging | | | | | | | | | | | | | | | | | |
| Flagging Sprays (15) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms | 4 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.2 | 520 | 1.4e-03 | NA | 4500 | 466 | 120 | NA | 81 |
| | sugarcane | 2.6 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.13 | 800 | 9.1e-04 | NA | 6900 | 717 | 180 | NA | 120 |
| | chemical fallow | 3 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.15 | 690 | 1.1e-03 | NA | 6000 | 621 | 150 | NA | 110 |
| | chemical fallow | 1.4 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.07 | 1500 | 4.9e-04 | NA | 13000 | 1331 | 330 | NA | 230 |
| | CRP/grasslands | 2 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.1 | 1000 | 7.0e-04 | NA | 8900 | 931 | 230 | NA | 160 |
| | corn, sorghum | 2 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.1 | 1000 | 7.0e-04 | NA | 8900 | 931 | 230 | NA | 160 |
| | corn, sorghum | 1 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.05 | 2100 | 3.5e-04 | NA | 18000 | 1863 | 460 | NA | 320 |
| | sod farms | 2 | 350 | NA | 0.01 | 0.07 | NA | NA | 0.1 | 1000 | 7.0e-04 | NA | 8900 | 931 | 230 | NA | 160 |

Footnotes:

- a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).
- b Amount handled per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000.
Fertilizer: For commercial bulk fertilizer admixture: If two pounds atrazine active ingredient per acre is impregnated onto 400 pounds of fertilizer (for the 400 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 10 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 400 pounds of fertilizer per acre rate is (960)(10) = 9600 pounds of atrazine active ingredient handled per day. Using the registrant-supplied upper limit of production, only 500 tons are produced, so (500)(10) = 5000 pounds of atrazine handled per day.
PHED liquid mixer/loader data for closed system. Arithmetic mean of operator exposure data from Helix (TM) Canadian seed treatment study submitted by Syngenta.
Application: 320 A/day estimated for 20-ton commercial truck spreader; 160 A/day reasonable max for 10-ton truck or on-farm equipment.
- c PPE dermal unit exposure represents long pants, long sleeved shirt, plus gloves and/or double layer body protection (as indicated in table), and no engineering controls. Unit exposure values from PHED Surrogate Exposure Guide - Draft August, 1998, except scenarios 7, 12 & 13 based on Outdoor Residential Exposure Task Force studies (MRID 449722-01; ORETF Study Number OMA001 and OMA002).
- d PPE inhalation unit exposure represents a dust/mist respirator -- calculated using an 80% PF from baseline inhalation exposure values in PHED Surrogate Exposure Guide - August 1998.
- e PPE dermal daily dose (mg/kg/day) = PPE daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg developmental female for intermediate-term assessment). For intermediate-term PPE dermal dose, an absorption factor of 6 percent applies.
PPE inhalation daily dose (mg/kg/day) = PPE inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).
- f Short-term PPE dermal MOE = NOAEL (104 mg/kg/day) / daily dose (mg/kg/day).
Short-term PPE inhalation MOE = NOAEL (6.25 mg/kg/day) / daily dose (mg/kg/day).
Combined dermal & inhalation MOE calculated: MOE [total] = 1 / [(1/MOEdermal) + (1/MOEinhalation)].
- g Intermediate-term PPE dermal MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).
Intermediate-term PPE inhalation MOE = NOAEL (1.8 mg/kg/day) / daily dose (mg/kg/day).
Combined MOE = NOAEL (1.8 mg/kg/day) / absorbed daily dermal + inhalation dose (mg/kg/day).

h Need information on number of pounds or volume of liquid fertilizer treated per day.

See PPE = no data at baseline, see exposures and risks with personal protective equipment

See Engineering Controls = no data at baseline or PPE, see exposures and risks with engineering controls

CRP = Conservation Reserve Program

UNK= Unknown

NA = not applicable

ND = No Data for this scenario

NG = no gloves; for flaggers gloves do not provide increased protection over baseline attire; PPE for flaggers is the addition of double-layer body protection to baseline attire.

NN= not needed -- MOEs greater than 100 at baseline

dl = double layer clothing

g = gloves

resp = respirator

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|--|--|--|---|---|---|---|---|---|--|--|--|--|--|---|
| Exposure Scenario | Crop Type | Applica- tion Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) _ PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| Mixer/Loader | | | | | | | | | | | | | | | |
| Mixing/Loading Liquid Formulations for Aerial Application (1a) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL | 4 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 520 | 430 | 150 | 130 | 930 | 590 | 130 | 110 |
| | sugarcane | 2.6 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 800 | 660 | 230 | 200 | 1400 | 910 | 200 | 160 |
| | chemical fallow | 3 | 1200 | 0.0086 | 0.083 | 0.01 | 0.13 | 200 | 170 | NA | NA | NA | NA | NA | NA |
| | chemical fallow | 3 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 690 | 570 | 200 | 170 | 1200 | 790 | 170 | 140 |
| | chemical fallow | 1.4 | 1200 | 0.0086 | 0.083 | 0.01 | 0.13 | 430 | 360 | NA | NA | NA | NA | NA | NA |
| | chemical fallow | 1.4 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 1500 | 1200 | 430 | 370 | 2700 | 1700 | 370 | 300 |
| | CRP/grassla nds | 2 | 1200 | 0.0086 | 0.083 | 0.01 | 0.13 | 300 | 250 | NA | NA | NA | NA | NA | NA |
| | CRP/grassla nds | 2 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 1000 | 850 | 300 | 260 | 1900 | 1200 | 260 | 210 |
| | corn, sorghum | 2 | 1200 | 0.0086 | 0.083 | 0.01 | 0.13 | 300 | 250 | NA | NA | NA | NA | NA | NA |
| | corn, sorghum | 2 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 1000 | 850 | 300 | 260 | 1900 | 1200 | 260 | 210 |
| | corn, sorghum | 1 | 1200 | 0.0086 | 0.083 | 0.01 | 0.13 | 610 | 500 | NA | NA | NA | NA | NA | NA |
| | corn, sorghum | 1 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 2100 | 1700 | 600 | 510 | 3700 | 2400 | 520 | 420 |
| sod farms | 2 | 350 | 0.0086 | 0.083 | 0.01 | 0.13 | 1000 | 850 | 300 | 260 | 1900 | 1200 | 260 | 210 | |
| Mixing/Loading Liquid Formulations for Groundboom Application (1b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.0086 | 0.083 | 0.01 | 0.13 | 2300 | 1900 | 650 | 560 | 4100 | 2600 | 560 | 460 |
| | sugarcane | 2.6 | 80 | 0.0086 | 0.083 | 0.01 | 0.13 | 3500 | 2900 | 1000 | 870 | 6300 | 4000 | 870 | 710 |
| | chemical fallow | 3 | 450 | 0.0086 | 0.083 | 0.01 | 0.13 | 540 | 440 | 160 | 130 | 960 | 620 | 130 | 110 |
| | chemical fallow | 3 | 200 | 0.0086 | 0.083 | 0.01 | 0.13 | 1200 | 1000 | 350 | 300 | 2200 | 1400 | 300 | 250 |
| | chemical fallow | 1.4 | 450 | 0.0086 | 0.083 | 0.01 | 0.13 | 1200 | 950 | 330 | 290 | 2100 | 1300 | 290 | 230 |
| | chemical | 1.4 | 200 | 0.0086 | 0.083 | 0.01 | 0.13 | 2600 | 2100 | 750 | 640 | 4600 | 3000 | 640 | 530 |
| 24 | | | | | | | | | | | | | | | |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|-----------------------------|--|---|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|---|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| | fallow | | | | | | | | | | | | | | |
| | CRP/grasslands | 2 | 450 | 0.0086 | 0.083 | 0.01 | 0.13 | 810 | 660 | 230 | 200 | 1400 | 920 | 200 | 160 |
| | CRP/grasslands | 2 | 200 | 0.0086 | 0.083 | 0.01 | 0.13 | 1800 | 1500 | 520 | 450 | 3300 | 2100 | 450 | 370 |
| | corn, sorghum | 2 | 450 | 0.0086 | 0.083 | 0.01 | 0.13 | 810 | 660 | 230 | 200 | 1400 | 920 | 200 | 160 |
| | corn, sorghum | 2 | 200 | 0.0086 | 0.083 | 0.01 | 0.13 | 1800 | 1500 | 520 | 450 | 3300 | 2100 | 450 | 370 |
| | corn, sorghum | 1 | 450 | 0.0086 | 0.083 | 0.01 | 0.13 | 1600 | 1300 | 470 | 400 | 2900 | 1800 | 400 | 330 |
| | corn, sorghum | 1 | 200 | 0.0086 | 0.083 | 0.01 | 0.13 | 3600 | 3000 | 1000 | 900 | 6500 | 4200 | 900 | 740 |
| | roadsides | 1 | 40 | 0.0086 | 0.083 | 0.01 | 0.13 | 18000 | 15000 | 5200 | 4500 | 33000 | 21000 | 4500 | 3700 |
| | bermuda grass rights of way | 4 | 40 | 0.0086 | 0.083 | 0.01 | 0.13 | 4600 | 3700 | 1300 | 1100 | 8100 | 5200 | 1100 | 920 |
| | golf course turf | 2 | 40 | 0.0086 | 0.083 | 0.01 | 0.13 | 9100 | 7500 | 2600 | 2300 | 16000 | 10000 | 2300 | 1800 |
| | sod farms | 2 | 80 | 0.0086 | 0.083 | 0.01 | 0.13 | 4600 | 3700 | 1300 | 1100 | 8100 | 5200 | 1100 | 920 |
| Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c) | roadsides | 1 | 40 | 0.0086 | 0.083 | 0.01 | 0.13 | 18000 | 15000 | 5200 | 4500 | 33000 | 21000 | 4500 | 3700 |
| | bermuda grass rights of way | 4 | 40 | 0.0086 | 0.083 | 0.01 | 0.13 | 4600 | 3700 | 1300 | 1100 | 8100 | 5200 | 1100 | 920 |
| Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d) | lawns, golf courses | 2 | 100 | 0.0086 | 0.083 | 0.01 | 0.13 | 3600 | 3000 | 1000 | 900 | 6500 | 4200 | 900 | 740 |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|--|---|---|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|---|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| Mixing/Loading/Incorporating Liquid Formulations onto Liquid or Dry Bulk Fertilizer (1e) | commercial fertilizer for corn, sorghum: *PHED data | 2 | 960 tons | 0.0086 | 0.083 | 0.01 | | 64 | | 22 | | 140 | | 19 | |
| | | | 500 tons | | | 0.01 | | 120 | | 42 | | 260 | | 36 | |
| | | | 500 tons | | | 0.01 | | 170 | | 110 | | 180 | | 67 | |
| | commercial fertilizer for corn, sorghum: *PHED data | 1 | 960 tons | 0.0086 | 0.083 | 0.01 | | 120 | | 44 | | 270 | | 38 | |
| | | | 500 tons | | | 0.01 | | 230 | | 84 | | 520 | | 22 | |
| | | | 500 tons | | | 0.01 | | 350 | | 220 | | 360 | | 130 | |
| | on-farm fertilizer for corn, sorghum | 2 | 160 | 0.0086 | 0.083 | | | 1900 | | NA | | NA | | NA | |
| | | 1 | 160 | | | | | 3800 | | NA | | NA | | NA | |
| | | | | | | | | | | | | | | | |
| Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a) | conifer forests, sugarcane, conifer (Christmas tree) farms, turf for sod in FL | 4 | 350 | 0.0098 | 0.24 | | | 380 | | 130 | | 320 | | 93 | |
| | sugarcane | 2.6 | 350 | 0.0098 | 0.24 | | | 580 | | 200 | | 490 | | 140 | |
| | chemical fallow | 3 | 1200 | 0.0098 | 0.24 | | | 150 | | NA | NA | NA | NA | NA | NA |
| | chemical fallow | 3 | 350 | 0.0098 | 0.24 | | | 500 | | 170 | | 430 | | 120 | |
| | chemical fallow | 1.4 | 1200 | 0.0098 | 0.24 | | | 320 | | NA | NA | NA | NA | NA | NA |
| | chemical fallow | 1.4 | 350 | 0.0098 | 0.24 | | | 1100 | | 370 | | 920 | | 270 | |
| | CRP/grasslands | 2 | 1200 | 0.0098 | 0.24 | | | 220 | | NA | NA | NA | NA | NA | NA |
| | CRP/grasslands | 2 | 350 | 0.0098 | 0.24 | | | 750 | | 260 | | 640 | | 190 | |
| | corn, | 2 | 1200 | 0.0098 | 0.24 | | | 220 | | NA | NA | NA | NA | NA | NA |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|--|---|---|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|---|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| | sorghum | | | | | | | | | | | | | | |
| | corn, sorghum | 2 | 350 | 0.0098 | 0.24 | | | 750 | | 260 | | 640 | | 190 | |
| | corn, sorghum | 1 | 1200 | 0.0098 | 0.24 | | | 440 | | NA | NA | NA | NA | NA | NA |
| | corn, sorghum | 1 | 350 | 0.0098 | 0.24 | | | 1500 | | 520 | | 1300 | | 370 | |
| | sod farms | 2 | 350 | 0.0098 | 0.24 | | | 750 | | 260 | | 640 | | 190 | |
| Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.0098 | 0.24 | | | 1600 | | 570 | | 1400 | | 410 | |
| | sugarcane | 2.6 | 80 | 0.0098 | 0.24 | | | 2500 | | 880 | | 2200 | | 630 | |
| | chemical fallow | 3 | 450 | 0.0098 | 0.24 | | | 400 | | 140 | | 330 | | 97 | |
| | chemical fallow | 3 | 200 | 0.0098 | 0.24 | | | 880 | | 310 | | 750 | | 220 | |
| | chemical fallow | 1.4 | 450 | 0.0098 | 0.24 | | | 840 | | 290 | | 710 | | 210 | |
| | chemical fallow | 1.4 | 200 | 0.0098 | 0.24 | | | 1900 | | 660 | | 1600 | | 470 | |
| | CRP/grasslands | 2 | 450 | 0.0098 | 0.24 | | | 580 | | 200 | | 500 | | 140 | |
| | CRP/grasslands | 2 | 200 | 0.0098 | 0.24 | | | 1300 | | 460 | | 1100 | | 330 | |
| | corn, sorghum | 2 | 450 | 0.0098 | 0.24 | | | 580 | | 200 | | 500 | | 140 | |
| | corn, sorghum | 2 | 200 | 0.0098 | 0.24 | | | 1300 | | 460 | | 1100 | | 330 | |
| | corn, sorghum | 1 | 450 | 0.0098 | 0.24 | | | 1200 | | 410 | | 1000 | | 290 | |
| | corn, sorghum | 1 | 200 | 0.0098 | 0.24 | | | 2600 | | 920 | | 2300 | | 650 | |
| | roadsides | 1 | 40 | 0.0098 | 0.24 | | | 13000 | | 4600 | | 11000 | | 3300 | |
| | roadsides | 4 | 40 | 0.0098 | 0.24 | | | 3300 | | 1100 | | 2800 | | 820 | |
| | golf course turf | 2 | 40 | 0.0098 | 0.24 | | | 6600 | | 2300 | | 5600 | | 1600 | |
| | sod farms | 2 | 80 | 0.0098 | 0.24 | | | 3300 | | 1100 | | 2800 | | 820 | |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|---|--|---|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|---|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c) | roadsides | 1 | 40 | 0.0098 | 0.24 | | | 13000 | | 4600 | | 11000 | | 3300 | |
| | roadsides | 4 | 40 | 0.0098 | 0.24 | | | 3300 | | 1100 | | 2800 | | 820 | |
| Loading Granular Formulations (3) | sod farms | 2 | 80 | 0.00017 | 0.034 | | | 62000 | | 66000 | | 20000 | | 15000 | |
| | golf course turf | 2 | 40 | 0.00017 | 0.034 | | | 120000 | | 130000 | | 40000 | | 31000 | |
| Applicator | | | | | | | | | | | | | | | |
| Applying Liquids with Aircraft (4) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL | 4 | 350 | 0.005 | 0.068 | | | 850 | | 260 | | 1100 | | 210 | |
| | sugarcane | 2.6 | 350 | 0.005 | 0.068 | | | 1300 | | 400 | | 1700 | | 320 | |
| | chemical fallow | 3 | 1200 | 0.005 | 0.068 | | | 330 | | NA | NA | NA | NA | NA | NA |
| | chemical fallow | 3 | 350 | 0.005 | 0.068 | | | 1100 | | 340 | | 1500 | | 280 | |
| | chemical fallow | 1.4 | 1200 | 0.005 | 0.068 | | | 710 | | NA | NA | NA | NA | NA | NA |
| | chemical fallow | 1.4 | 350 | 0.005 | 0.068 | | | 2400 | | 730 | | 3200 | | 600 | |
| | CRP/grasslands | 2 | 1200 | 0.005 | 0.068 | | | 500 | | NA | NA | NA | NA | NA | NA |
| | CRP/grasslands | 2 | 350 | 0.005 | 0.068 | | | 1700 | | 510 | | 2300 | | 420 | |
| | corn, sorghum | 2 | 1200 | 0.005 | 0.068 | | | 500 | | NA | NA | NA | NA | NA | NA |
| | corn, sorghum | 2 | 350 | 0.005 | 0.068 | | | 1700 | | 510 | | 2300 | | 420 | |
| | corn, sorghum | 1 | 1200 | 0.005 | 0.068 | | | 990 | | NA | NA | NA | NA | NA | NA |
| | corn, sorghum | 1 | 350 | 0.005 | 0.068 | | | 3400 | | 1000 | | 4500 | | 840 | |
| | sod farms | 2 | 350 | 0.005 | 0.068 | | | 1700 | | 510 | | 2300 | | 420 | |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|--|--|--|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|--|---|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer/day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| Applying Liquids for Groundboom Application (5) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 0.005 | 0.043 | 0.0083 | 0.011 | 4000 | 2700 | 1100 | 680 | 7800 | 7200 | 980 | 620 |
| | sugarcane | 2.6 | 80 | 0.005 | 0.043 | 0.0083 | 0.011 | 6100 | 4100 | 1700 | 1000 | 12000 | 11000 | 1500 | 950 |
| | chemical fallow | 3 | 450 | 0.005 | 0.043 | 0.0083 | 0.011 | 940 | 640 | 270 | 160 | 1900 | 1700 | 230 | 150 |
| | chemical fallow | 3 | 200 | 0.005 | 0.043 | 0.0083 | 0.011 | 2100 | 1400 | 600 | 360 | 4200 | 3800 | 520 | 330 |
| | chemical fallow | 1.4 | 450 | 0.005 | 0.043 | 0.0083 | 0.011 | 2000 | 1400 | 570 | 340 | 4000 | 3600 | 500 | 310 |
| | chemical fallow | 1.4 | 200 | 0.005 | 0.043 | 0.0083 | 0.011 | 4500 | 3100 | 1300 | 770 | 9000 | 8200 | 1100 | 710 |
| | CRP/grasslands | 2 | 450 | 0.005 | 0.043 | 0.0083 | 0.011 | 1400 | 950 | 400 | 240 | 2800 | 2600 | 350 | 220 |
| | CRP/grasslands | 2 | 200 | 0.005 | 0.043 | 0.0083 | 0.011 | 3200 | 2100 | 900 | 540 | 6300 | 5700 | 790 | 500 |
| | corn, sorghum | 2 | 450 | 0.005 | 0.043 | 0.0083 | 0.011 | 1400 | 950 | 400 | 240 | 2800 | 2600 | 350 | 220 |
| | corn, sorghum | 2 | 200 | 0.005 | 0.043 | 0.0083 | 0.011 | 3200 | 2100 | 900 | 540 | 6300 | 5700 | 790 | 500 |
| | corn, sorghum | 1 | 450 | 0.005 | 0.043 | 0.0083 | 0.011 | 2800 | 1900 | 800 | 480 | 5600 | 5100 | 700 | 440 |
| | corn, sorghum | 1 | 200 | 0.005 | 0.043 | 0.0083 | 0.011 | 6400 | 4300 | 1800 | 1100 | 13000 | 11000 | 1600 | 990 |
| | roadsides | 4 | 40 | 0.005 | 0.043 | 0.0083 | 0.047 | 8000 | 5000 | 2300 | 1400 | 16000 | 14000 | 2000 | 1200 |
| | roadsides | 1 | 40 | 0.005 | 0.043 | 0.0083 | 0.047 | 32000 | 20000 | 9000 | 5400 | 63000 | 57000 | 7900 | 5000 |
| | golf course turf | 2 | 40 | 0.005 | 0.043 | 0.0083 | 0.047 | 16000 | 10000 | 4500 | 2700 | 31000 | 29000 | 3900 | 2500 |
| | sod farms, conifer (Christmas tree) farms | 2 | 80 | 0.005 | 0.043 | 0.0083 | 0.047 | 8000 | 5000 | 2300 | 1400 | 16000 | 14000 | 2000 | 1200 |
| Applying Liquids with a Rights-of-Way Sprayer (6) | roadsides | 4 | 40 | NF | NF | | | | | | | | | | |
| | roadsides | 1 | 40 | NF | NF | | | | | | | | | | |
| Applying Liquids with a Handgun (7) | lawns, golf courses | 2 | 5 | NF | NF | | | | | | | | | | |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|--------------------------------------|---|---|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|---|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer) (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) _ PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| Applying Impregnated Dry Bulk Granular Fertilizer by Tractor Drawn Spreader or with Truck with a Spreader (8) | corn, sorghum: commercial | 2 | 320 | 0.002 | 0.22 | | | 1000 | | 1300 | | 770 | | 490 | |
| | private on-farm | | 160 | | | | | 1900 | | 2700 | | 1500 | | 980 | |
| | commercial | 1 | 320 | | | | | 1900 | | 2700 | | 1500 | | 980 | |
| | private on-farm | | 160 | | | | | 4000 | | 5400 | | 3100 | | 2000 | |
| Applying Granular with a Tractor Drawn Spreader (9) | on farm fertilizer for corn, sorghum | 2 | 200 | 0.002 | 0.22 | | | 3200 | | 2300 | | 1200 | | 790 | |
| | | 2 | 80 | 0.002 | 0.22 | | | 7900 | | 5600 | | 3100 | | 2000 | |
| | | 1 | 200 | 0.002 | 0.22 | | | 6400 | | 4500 | | 2500 | | 1600 | |
| | | 1 | 80 | 0.002 | 0.22 | | | 16000 | | 11000 | | 6100 | | 4000 | |
| | golf course turf | 2 | 40 | 0.002 | 0.22 | | | 16000 | | 11000 | | 6100 | | 4000 | |
| Mixer/Loader/Applicator | | | | | | | | | | | | | | | |
| Backpack Sprayer (LCO) (10) | lawns, golf courses | 2 | 5 | Not Feasible | | | | | | | | | | | |
| Low Pressure Handwand - Liquid Formulations (ICO) (11) | lawns, golf courses | 2 | 5 | | | | | | | | | | | | |
| Lawn Handgun (ICO) all formulations(12) | lawns, golf courses | 2 | 5 | | | | | | | | | | | | |
| Granulars with a Push Type Spreader (LCO) (13) | lawns, golf courses | 2 | 5 | | | | | | | | | | | | |
| Granulars with a Bellygrinder (LCO) (14) | lawns, golf courses | 2 | 1 | | | | | | | | | | | | |
| Flagging | | | | | | | | | | | | | | | |

| Table 7: Atrazine: Short-term Handler Exposure and Risk Estimates with Engineering Controls (PHED and Atrazine Corn Handler Study) | | | | | | | | | | Intermediate-term Risk Estimates | | | | | |
|--|---|--|---|---|---|--|--|---------------------------------------|--|------------------------------------|---|--|---|---|--|
| Exposure Scenario | Crop Type | Application Rate (lb ai) & lb fertilizer (a) | Acres Treated or tons (t) fertilizer /day (b) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED Data (c) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED Data (d) | Eng Con Dermal Unit Exposure (mg/lb ai) PHED + Corn Study Data (e) | Eng Con Inhalation Unit Exposure (ug/lb ai) PHED + Corn Study Data (e) | Eng Con Aggregate MOE - PHED Data (i) | Eng Con Aggregate MOE - PHED + Corn Study Data (i) | Eng Con Dermal MOE - PHED Data (h) | Eng Con Dermal MOE - PHED + Corn Study Data (h) | Eng Con Inhalation MOE - PHED Data (h) | Eng Con Inhalation MOE - PHED + Corn Study Data (h) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED Data (i) | Aggregate MOE (Eng Con Dermal + Eng Con Inh) - PHED + Corn Study Data (i) |
| Flagging Aerial Sprays (15) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms | 4 | 350 | 0.005 | 0.043 | | | 910 | | 260 | | 1800 | | 220 | |
| | sugarcane | 2.6 | 350 | 0.005 | 0.043 | | | 1400 | | 400 | | 2800 | | 350 | |
| | chemical fallow | 3 | 350 | 0.005 | 0.043 | | | 1200 | | 340 | | 2400 | | 300 | |
| | chemical fallow | 1.4 | 350 | 0.005 | 0.043 | | | 2600 | | 730 | | 5100 | | 640 | |
| | CRP/ grasslands | 2 | 350 | 0.005 | 0.043 | | | 1800 | | 510 | | 3600 | | 450 | |
| | corn, sorghum | 2 | 350 | 0.005 | 0.043 | | | 1800 | | 510 | | 3600 | | 450 | |
| | corn, sorghum | 1 | 350 | 0.005 | 0.043 | | | 3600 | | 1000 | | 7200 | | 900 | |
| | sod farms | 2 | 350 | 0.005 | 0.043 | | | 1800 | | 510 | | 3600 | | 450 | |

Footnotes:

- a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and chemical fallow (1.4 lb ai/acre).
- b Acres treated per day based on Exposure SAC Policy # 9 “Standard Values for Daily Acres Treated In Agriculture,” Revised June 23, 2000.
For commercial bulk fertilizer admixture: If two pounds atrazine active ingredient per acre is impregnated onto 400 pounds of fertilizer (for the 400 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 10 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 400 pounds of fertilizer per acre rate is (960)(10) = 9600 pounds of atrazine active ingredient handled per day. Using the registrant-supplied upper limit of production, only 500 tons are produced, so (500)(10) = 5000 pounds of atrazine handled per day. PHED data used for closed system liquid admixture. Arithmetic mean of operator exposure data from Helix (TM) Canadian seed treatment study submitted by Syngenta. Application: 320 A/day estimated for 20-ton commercial truck spreader; 160 A/day reasonable max for 10-ton truck or on-farm equipment.
- c Engineering control dermal unit exposure values from PHED Surrogate Exposure Guide - Draft August, 1998 represent:
1a, 1b, 1c, 1d, 1e, 1f: closed mixing, single layer clothing, and chemical resistant gloves
2a, 2b, 2c water soluble packets, single layer clothing, and chemical resistant gloves
3 lock and load, single layer clothing and chemical resistant gloves
4, enclosed cockpit/cockpit, single layer clothing and no gloves
5, 8, 9 enclosed cab, single layer clothing and no gloves
10-14 engineering controls currently not feasible for hand application methods
15 enclosed cab, single layer of clothing and no gloves
- d Engineering control inhalation unit exposure values from PHED Surrogate Exposure Guide - Draft August 1998 represent used of a dust/mist respirator (80 percent protection factor over baseline).
- e Dermal and inhalation unit exposure supplied by Novartis/Syngenta (MRID 443154-04)
- f Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg adult female -- for developmental effects -- for intermediate-term assessment). For the intermediate-term absorbed dermal dose an absorption factor of 6 percent was applied.
Inhalation daily dose (mg/kg/day) = inhalation unit exposure (ug/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 ug) / body weight (60 kg developmental female for both short-term and intermediate-term assessment).

g Short-term dermal MOE = NOAEL (104 mg/kg/day based on a dermal rat study) / daily dose (mg/kg/day).
Short-term inhalation MOE = NOAEL (6.25 mg/kg/day) / daily dose (mg/kg/day).
Combined dermal & inhalation MOE calculated: $MOE [total] = 1 / [(1/MOE_{dermal}) + (1/MOE_{inhalation})]$.

g Intermediate-term dermal MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).
Combined dermal & inhalation MOE calculated: $MOE [total] = 1 / [(1/MOE_{dermal}) + (1/MOE_{inhalation})]$.

CRP = Conservation Reserve Program

NN = Not needed -- MOE > 100 at previous risk mitigation level

NF = Not feasible -- no engineering control known for this application method

NA = Not applicable to this scenario

Table 8: Summary of Occupational Short-term and Intermediate-term Combined Dermal + Inhalation Handler Risks from Atrazine (Using PHED, ORETF, and Combined PHED/Handler Study Data)

| Exposure Scenario | Crop Type | Applicati on Rate (lb ai or lb ai/gallon & lbs fertilizer) (a) | Area Treated per Day (Acres or Gallons) (b) | Baseline (c) | | PPE (Gloves, Coveralls, Respirator) (d) | | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) |
|---|--|---|--|--------------------|------------------------------|--|------------------------------|--|---|--|--|
| | | | | Short- term (g) | Intermedi ate-term (h) | Short- term (g) | Intermedi ate-term (h) | Short-term (g) | | Intermediate-term (h) | |
| Mixer/Loader | | | | | | | | | | | |
| Mixing/Loading Liquid Formulations for Aerial Application (1a) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL | 4 | 350 | 2 | 0.4 | 248 | 61 | 520 | 430 | 130 | 110 |
| | sugarcane | 3 | 350 | 3 | 0.7 | 381 | 94 | 800 | 660 | 200 | 160 |
| | chemical fallow | 3 3 | 1,200 | 1 | 0.2 | 96 | 24 | 200 | 170 | 50 | 41 |
| | | | 350 | 2 | 0.6 | 330 | 82 | 690 | 570 | 170 | 140 |
| | | 1 1.4 | 1,200 | 1 | 0.4 | 206 | 51 | 430 | 360 | 110 | 88 |
| | 350 | | 5 | 1.3 | 708 | 170 | 1,500 | 1,200 | 370 | 300 | |
| | CRP/grasslands | 2 2 | 1,200 | 1 | 0.3 | 144 | 36 | 300 | 250 | 75 | 62 |
| | | | 350 | 4 | 0.9 | 495 | 120 | 1,000 | 850 | 260 | 210 |
| | corn, sorghum | 2 | 1,200 | 1 | 0.3 | 144 | 36 | 300 | 250 | 75 | 62 |
| | | | 350 | 4 | 0.9 | 495 | 120 | 1,000 | 850 | 260 | 210 |
| 1 1 | | 1,200 | 2 | 0.5 | 289 | 71 | 610 | 500 | 150 | 120 | |
| 350 | 7 | 2 | 991 | 240 | 2,100 | 1,700 | 520 | 420 | | | |
| sod farms | 2 | 350 | 4 | 1 | 495 | 120 | 1,000 | 850 | 260 | 210 | |
| Mixing/Loading Liquid Formulations for Groundboom Application (1b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 8 | 2 | 1,084 | 270 | 2,300 | 1,900 | 560 | 460 |
| | sugarcane | 3 | 80 | 12 | 3 | 1,667 | 410 | 3,500 | 2,900 | 870 | 710 |
| | chemical fallow | 3 3 | 450 | 2 | 0.5 | 257 | 63 | 540 | 440 | 130 | 110 |
| | | | 200 | 4 | 1 | 578 | 140 | 1,200 | 1,000 | 300 | 250 |
| | | 1 1.4 | 450 | 4 | 1 | 550 | 140 | 1,200 | 950 | 290 | 230 |
| | 200 | | 9 | 2 | 1,238 | 310 | 2,600 | 2,100 | 640 | 530 | |
| | CRP/grasslands | 2 2 | 450 | 3 | 1 | 385 | 95 | 810 | 660 | 200 | 160 |
| | | | 200 | 6 | 2 | 867 | 210 | 1,800 | 1,500 | 450 | 370 |
| | corn, sorghum | 2 2 | 450 | 3 | 1 | 385 | 95 | 810 | 660 | 200 | 160 |
| | | | 200 | 6 | 2 | 867 | 210 | 1,800 | 1,500 | 450 | 370 |
| | | 1 1 | 450 | 6 | 1 | 771 | 190 | 1,600 | 1,300 | 400 | 330 |
| | 200 | 12 | 3 | 1,734 | 430 | 3,600 | 3,000 | 900 | 740 | | |
| | roadsides | 1 | 40 | 62 | 15 | 8,669 | 2,100 | 18,000 | 15,000 | 4,500 | 3,700 |
| | bermuda grass rights of way | 4 | 40 | 16 | 4 | 2,167 | 540 | 4,600 | 3,700 | 1,100 | 920 |
| | golf course turf | 2 | 40 | 31 | 8 | 4,335 | 1,100 | 9,100 | 7,500 | 2,300 | 1,800 |
| sod farms | 2 | 80 | 16 | 4 | 2,167 | 540 | 4,600 | 3,700 | 1,100 | 920 | |

Table 8: Summary of Occupational Short-term and Intermediate-term Combined Dermal + Inhalation Handler Risks from Atrazine (Using PHED, ORETF, and Combined PHED/Handler Study Data)

| Exposure Scenario | Crop Type | Applicati on Rate (lb ai or lb ai/gallon & lbs fertilizer) (a) | Area Treated per Day (Acres or Gallons) (b) | Baseline (c) | | PPE (Gloves, Coveralls, Respirator) (d) | | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) |
|---|---|--|--|--------------------------|------------------------------|--|------------------------------|--|---|--|--|
| | | | | Short- term (g) | Intermedi ate-term (h) | Short- term (g) | Intermedi ate-term (h) | Short-term (g) | | Intermediate-term (h) | |
| Mixing/Loading Liquid Formulations for Rights-of-Way Sprayer (1c) | roadsides | 1 | 40 | 62 | 15 | 8,669 | 2,100 | 18,000 | 15,000 | 4,500 | 3,700 |
| | bermuda grass rights of way | 4 | 40 | 16 | 4 | 2,167 | 540 | 4,600 | 3,700 | 1,100 | 920 |
| Mixing/Loading Liquid Formulations for Lawn Handgun Application (LCO) (1d) | lawns, golf courses | 2 | 100 | 12 | 3 | 1,734 | 430 | 3,600 | 3,000 | 900 | 740 |
| Mixing/Loading /Incorporating Liquid Formulations onto Liquid or Dry Bulk Fertilizer (1e) | commercial fertilizer for corn, sorghum: *PHED data *Helix study data | 2 | 960 tons | See Engineering Controls | | | | 64 | | 19 | |
| | | | 500 tons | See Engineering Controls | | | | 120 | | 36 | |
| | | 500 tons | See Engineering Controls | | | | 170 | | 67 | | |
| | commercial fertilizer for corn, sorghum: *PHED data *Helix Study data | 1 | 960 tons | See Engineering Controls | | | | 120 | | 38 | |
| | | | 500 tons | See Engineering Controls | | | | 230 | | 72 | |
| | | | 500 tons | See Engineering Controls | | | | 350 | | 130 | |
| | on-farm fertilizer for corn, sorghum | 2 | 160 | 8 | NA | 700 | NA | 1,900 | NA | NA | NA |
| | | 1 | 160 | 15 | NA | 1,400 | NA | 3,800 | NA | NA | NA |
| Mixing/Loading Dry Flowable (Water Dispersible Granule) for Aerial (2a) | conifer forests, sugarcane, conifer (Christmas tree) farms, turf for sod in FL | 4 | 350 | 66 | 16 | 105 | 26 | 380 | | 130 | |
| | sugarcane | 3 | 350 | 100 | 25 | 161 | 40 | 580 | | 140 | |
| | chemical fallow | 3 3 | 1,200 | 26 | 6 | 41 | 10 | 150 | | 36 | |
| | | | 350 | 88 | 22 | 140 | 35 | 500 | | 120 | |
| | chemical fallow | 1 1.4 | 1,200 | 55 | 14 | 87 | 22 | 320 | | 78 | |
| | | | 350 | 190 | 47 | 300 | 74 | 1,100 | | 270 | |
| | CRP/grasslands | 2 2 | 1,200 | 38 | 10 | 61 | 15 | 220 | | 54 | |
| | | | 350 | 130 | 33 | 210 | 52 | 750 | | 190 | |
| | corn, sorghum | 2 2 | 1,200 | 38 | 10 | 61 | 15 | 220 | | 54 | |
| | | | 350 | 130 | 33 | 210 | 52 | 750 | | 190 | |
| | | 1 1 | 1,200 | 77 | 19 | 122 | 30 | 440 | | 110 | |
| | | | 350 | 260 | 65 | 420 | 100 | 1,500 | | 370 | |
| sod farms | 2 | 350 | 130 | 33 | 210 | 52 | 750 | | 190 | | |

Table 8: Summary of Occupational Short-term and Intermediate-term Combined Dermal + Inhalation Handler Risks from Atrazine (Using PHED, ORETF, and Combined PHED/Handler Study Data)

| Exposure Scenario | Crop Type | Applicati on Rate (lb ai or lb ai/gallon & lbs fertilizer) (a) | Area Treated per Day (Acres or Gallons) (b) | Baseline (c) | | PPE (Gloves, Coveralls, Respirator) (d) | | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) |
|--|--|---|--|--------------------------|------------------------------|--|------------------------------|--|---|--|--|
| | | | | Short- term (g) | Intermedi ate-term (h) | Short- term (g) | Intermedi ate-term (h) | Short-term (g) | | Intermediate-term (h) | |
| Mixing/Loading Dry Flowables (water dispersible) for Groundboom Application (2b) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 290 | 71 | 459 | 110 | 1,600 | | 410 | |
| | sugarcane | 3 | 80 | 440 | 110 | 706 | 170 | 2,500 | | 630 | |
| | chemical fallow | 3 3 | 450 | 68 | 17 | 109 | 27 | 400 | | 97 | |
| | | | 200 | 150 | 38 | 245 | 61 | 880 | | 220 | |
| | | 1 1.4 | 450 | 150 | 36 | 233 | 58 | 840 | | 210 | |
| | | | 200 | 330 | 82 | 525 | 130 | 1,900 | | 470 | |
| | CRP/grasslands | 2 2 | 450 | 100 | 25 | 163 | 40 | 580 | | 140 | |
| | | | 200 | 230 | 57 | 367 | 91 | 1,300 | | 330 | |
| | corn, sorghum | 2 2 | 450 | 100 | 25 | 163 | 40 | 580 | | 140 | |
| | | | 200 | 230 | 57 | 367 | 91 | 1,300 | | 330 | |
| | | 1 1 | 450 | 210 | 51 | 326 | 81 | 1,200 | | 290 | |
| | | | 200 | 460 | 110 | 734 | 180 | 2,600 | | 650 | |
| Mixing/Loading Dry Flowables (water dispersible) for Rights of Way (2c) | roadsides | 1 | 40 | 2,300 | 570 | 3,672 | 910 | 13,000 | | 3,300 | |
| | | 4 | 40 | 580 | 140 | 918 | 230 | 3,300 | | 820 | |
| | sod farms | 2 | 80 | 1,200 | 310 | 5,023 | 1,200 | 62,000 | | 15,000 | |
| | golf course turf | 2 | 40 | 2,500 | 610 | 10,047 | 2,500 | 120,000 | | 31,000 | |
| | Applicator | | | | | | | | | | |
| Applying Liquids with Aircraft (4) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms in FL | 4 | 350 | See Engineering Controls | See Engineering Controls | 850 | | | | 210 | |
| | sugarcane | 3 | 350 | | | | | | | | |
| | chemical fallow | 3 3 | 1,200 | | | | | | | | |
| | | | 350 | | | | | | | | |
| | | 1 1.4 | 1,200 | | | | | | | | |
| | | | 350 | | | | | | | | |
| | CRP/grasslands | 2 2 | 1,200 | | | | | | | | |
| | | | 350 | | | | | | | | |
| | corn, sorghum | 2 2 | 1,200 | See Engineering Controls | See Engineering Controls | 500 | | | | 120 | |
| | | | 350 | | | | | | | | |
| | | | 1,200 | | | | | | | | |
| | | | 350 | | | | | | | | |

Table 8: Summary of Occupational Short-term and Intermediate-term Combined Dermal + Inhalation Handler Risks from Atrazine (Using PHED, ORETF, and Combined PHED/Handler Study Data)

| Exposure Scenario | Crop Type | Application Rate (lb ai or lb ai/gallon & lbs fertilizer) (a) | Area Treated per Day (Acres or Gallons) (b) | Baseline (c) | | PPE (Gloves, Coveralls, Respirator) (d) | | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) |
|--|--|---|---|----------------|-----------------------|---|-----------------------|-------------------------------------|---|-------------------------------------|---|
| | | | | Short-term (g) | Intermediate-term (h) | Short-term (g) | Intermediate-term (h) | Short-term (g) | | Intermediate-term (h) | |
| | | 1 1 | 1,200 | | | | | 990 | | 240 | |
| | | | 350 | | | | | 3,400 | | 840 | |
| | sod farms | 2 | 350 | | | | | 1,700 | | 420 | |
| Applying Liquids for Groundboom Application (5) | sugar cane, macademia nuts, guava, conifers, sod farms in FL | 4 | 80 | 860 | 210 | 1,690 | 420 | 4,000 | 2,700 | 980 | 620 |
| | sugarcane | 3 | 80 | 1,300 | 330 | 2,600 | 640 | 6,100 | 4,100 | 1,500 | 950 |
| | chemical fallow | 3 3 | 450 | 200 | 51 | 401 | 99 | 940 | 640 | 230 | 150 |
| | | | 200 | 460 | 110 | 901 | 220 | 2,100 | 1,400 | 520 | 330 |
| | | 1 1.4 | 450 | 440 | 110 | 858 | 210 | 2,000 | 1,400 | 500 | 310 |
| | CRP/grasslands | 2 2 | 200 | 990 | 240 | 1,931 | 480 | 4,500 | 3,100 | 1,100 | 710 |
| | | | 450 | 310 | 76 | 601 | 150 | 1,400 | 950 | 350 | 220 |
| | corn, sorghum | 2 2 | 200 | 690 | 170 | 1,352 | 330 | 3,200 | 2,100 | 790 | 500 |
| | | | 450 | 310 | 76 | 601 | 150 | 1,400 | 950 | 350 | 220 |
| | corn, sorghum | 1 1 | 200 | 690 | 170 | 1,352 | 330 | 3,200 | 2,100 | 790 | 500 |
| | | | 450 | 610 | 150 | 1,202 | 300 | 2,800 | 1,900 | 700 | 440 |
| | roadsides | 4 | 200 | 1,400 | 340 | 2,704 | 670 | 6,400 | 4,300 | 1,600 | 990 |
| | | | 40 | 1,700 | 430 | 3,380 | 840 | 8,000 | 5,000 | 2,000 | 1,200 |
| Applying Liquids with a Rights-of-Way Sprayer (6) | roadsides | 4 | 40 | 33 | 8 | 150 | 37 | ND | ND | ND | ND |
| | roadsides | 1 | 40 | 130 | 33 | 601 | 150 | ND | ND | ND | ND |
| Applying Liquids with a Handgun (7) (ORETF) | lawns, golf courses | 2 | 5 | ND | ND | 980 (G) | 240 (G) | NF | NF | | |
| Applying Impregnated Dry Bulk Granular Fertilizer with Tractor Drawn Spreader(8) | corn, sorghum | 2 | 320 | 190 | NA | 660 | NA | 1,000 | NA | NA | NA |
| | | | 160 | 380 | NA | 1,300 | NA | 1,900 | | NA | NA |
| | | 1 | 320 | 380 | NA | 1,300 | NA | 1,900 | | NA | NA |
| | | | 160 | 900 | NA | 2,600 | NA | 4,000 | | NA | NA |
| Applying Granular with a Tractor Drawn Spreader (9) | corn, sorghum | 2 2 | 200 | 610 | 150 | 2,221 | 550 | 3,200 | | 790 | |
| | | | 80 | 1,500 | 380 | 5,553 | 1,400 | 7,900 | | 2000 | |
| | | 1 | 200 | 1,200 | 300 | 4,442 | 1,100 | 6,400 | | 1600 | |

Table 8: Summary of Occupational Short-term and Intermediate-term Combined Dermal + Inhalation Handler Risks from Atrazine (Using PHED, ORETF, and Combined PHED/Handler Study Data)

| Exposure Scenario | Crop Type | Applicati on Rate (lb ai or lb ai/gallon & lbs fertilizer) (a) | Area Treated per Day (Acres or Gallons) (b) | Baseline (c) | | PPE (Gloves, Coveralls, Respirator) (d) | | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) | Engineering Controls: PHED Data (e) | Engineering Controls: PHED + Handler Study Data (f) |
|---|--|---|--|--------------------|------------------------------|--|------------------------------|--|---|--|--|
| | | | | Short- term (g) | Intermedi ate-term (h) | Short- term (g) | Intermedi ate-term (h) | Short-term (g) | | Intermediate-term (h) | |
| | | 1 | 80 | 3,000 | 750 | 11,100 | 2,700 | 16,000 | | 4000 | |
| | golf course turf | 2 | 40 | 3,000 | 750 | 11,100 | 2,700 | 16,000 | | 4000 | |
| Mixer/Loader/Applicator | | | | | | | | | | | |
| Backpack Sprayer (PCO) (10) | lawns, golf courses | 2 | 5 | ND | ND | 428 | 110 | Not Feasible | | | |
| Low Pressure Handwand - Liquid Formulations (PCO) (11) | lawns, golf courses | 2 | 5 | 7 | 2 | 1549 | 380 | Not Feasible | | | |
| Lawn Handgun (PCO) [ORETF] (12a)Liquid | lawns, golf courses | 2 | 5 | ND | ND | 1400 (G) | 340 (G) | Not Feasible | | | |
| (12b) WDG | | | | ND | ND | 1100 (G) | 290 (G) | | | | |
| (12c) WSP | | | | ND | ND | 920 (G) | 230 (G) | | | | |
| Granulars with a Push Type Spreader (PCO) [ORETF] (13) | lawns, golf courses | 2 | 5 | 1500 | 380 | 2100 (G) | 520 (G) | Not Feasible | | | |
| Granulars with a Bellygrinder (PCO) (14) | lawns, golf courses | 2 | 1 | 330 | 82 | 616 | 150 | Not Feasible | | | |
| Flagging | | | | | | | | | | | |
| Flagging Sprays (15) | conifer forests, sugarcane, conifer (Christmas tree) farms, sod farms | 4 | 350 | 310 | 76 | 466 | 120 | 910 | NA | 220 | NA |
| | sugarcane | 3 | 350 | 480 | 120 | 717 | 180 | 1,400 | | 350 | |
| | chemical fallow | 3 | 350 | 410 | 100 | 621 | 150 | 1,200 | | 300 | |
| | chemical fallow | 1.4 | 350 | 880 | 220 | 1,331 | 330 | 2,600 | | 640 | |
| | CRP/grasslands | 2 | 350 | 620 | 150 | 931 | 230 | 1,800 | | 450 | |
| | corn, sorghum | 2 | 350 | 620 | 150 | 931 | 230 | 1,800 | | 450 | |
| | corn, sorghum | 1 | 350 | 1,200 | 310 | 1,863 | 460 | 3,600 | | 900 | |
| | sod farms | 2 | 350 | 620 | 150 | 931 | 230 | 1,800 | | 450 | |

Footnotes:

a Application rates represent maximum rates determined from EPA registered labels for atrazine. Typical use rates as determined by BEAD were assessed for corn and sorghum (1.0 lb ai/acre), sugarcane (2.6 lb ai/acre) and

chemical fallow (1.4 lb ai/acre).

For commercial bulk fertilizer admixture: If two pounds atrazine active ingredient per acre is impregnated onto 400 pounds of fertilizer (for the 400 pounds fertilizer per acre rate), each ton (2000 pounds) of fertilizer would require 10 pounds of atrazine active ingredient. Thus, the total amount of active ingredient for 960 tons for the two pound active ingredient per 400 pounds of fertilizer per acre rate is $(960)(10) = 9600$ pounds of atrazine active ingredient handled per day. Using the registrant-supplied upper limit of production, only 500 tons are produced, so $(500)(10) = 5000$ pounds of atrazine handled per day. PHED data used for closed system liquid admixture. Arithmetic mean of operator exposure data from Helix (TM) Canadian seed treatment study submitted by Syngenta. Estimated Application: 320 A/day estimated for 20-ton commercial truck spreader; 160 A/day reasonable max for 10-ton truck or on-farm equipment.

- b Acres treated per day based on Exposure SAC Policy # 9 "Standard Values for Daily Acres Treated In Agriculture," Revised June 23, 2000. Also high acreage estimated from submitted study data 75th percentile for corn = 450 acres/day. Some high and typical acreage used to characterize short and intermediate term exposure.
- c Baseline MOEs: see Occupational Short-term and Intermediate-term Handler Risks from Atrazine at Baseline Table.
- d PPE MOEs: see Occupational Short-term and Intermediate-term Handler Risks from Atrazine with PPE Risk Mitigation Table.
- e Engineering Control MOEs: see Occupational Short-term and Intermediate-term Handler Risks from Atrazine with Engineering Controls Table.
- f Engineering control dermal unit exposure values taken from submitted by Novartis Crop Protection Inc., passive dosimetry data combined with PHED corresponding scenario data MRID 443154-04.
- g Short-term dermal MOE = NOAEL (104 mg/kg/day) / daily dose (mg/kg/day).
Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult for short-term and 60 kg adult female -- for developmental effects -- for intermediate-term assessment). For intermediate-term dermal dose an absorption factor of 6 percent applies.
Short-term inhalation MOE = NOAEL (6.25 mg/kg/day) / daily dose (mg/kg/day).
Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (70 kg adult for short term and 60 kg developmental female for intermediate-term assessment).
- h Intermediate-term dermal and inhalation MOE = NOAEL (1.8 mg/kg/day based on an oral developmental study) / daily dose (mg/kg/day).

CRP = Conservation Reserve Program

UNK = Unknown -- additional use information needed

NN = Not needed -- MOE > 100 at previous risk mitigation level

NF = Not feasible -- no engineering control known for this application method

Table 9. Turf Transferable (TTR) and Dislodgeable Foliar Residue (DFR) Values from Registrant Submitted Studies (used in Postapplication Assessment)

| MRID 449580-01 Atrazine Liquid Turf Application Study Rate: 2 lb ai/acre | | | MRID 449588-01 Atrazine Granular Turf Application Study Rate: 2 lb ai/acre | | | | | MRID 448836-01 Atrazine Liquid Application to Corn Study Rate: 2.0 lb ai/acre - 4L Formulation 2.5 lb ai/acre - Dry Flowable Formulation | | | |
|--|--------------------|--------------------|--|-----------------|-----------|-----------------|-----------|---|--------------------------------------|---|--|
| DAT (days) | GA TTR (µg/cm²) | NC TTR (µg/cm²) | DAT (days) | GA TTR (µg/cm²) | | FL TTR (µg/cm²) | | DAT (days) | MO DFR (µg/cm²) 4L Formulation | MO DFR (µg/cm²) Dry Flowable Formulation | MO DFR (µg/cm²) Dry Flowable Formulation (Normalized to represent 2 lb ai/a application) |
| | | | | Non- irrig. | Irrigated | Non- irrig. | Irrigated | | | | |
| 0 | 0.182 | 0.219 | 0 | 0.0585 | | 0.162 | | 0 | | | |
| 0.5 | 0.241 | 1.32 | 0.167 | -- | 0.0744 | 0.216 | | 0.167 | 2.64 | 4.21 | 3.37 |
| 1 | 0.117 | 0.116 | 0.79 | 0.0145 | | -- | 0.0117 | 0.5 | 1.61 | 2.7 | 2.16 |
| 3 | 0.2 | 0.135 | 1 | 0.0351 | 0.00771 | 0.0883 | 0.00974 | 1 | 1.54 | 2.04 | 1.63 |
| 5 | 0.117 | 0.139 | 3 | 0.0182 | 0.00805 | 0.0536 | 0.00203 | 2 | 1.35 | 1.92 | 1.54 |
| 7 | 0.0658 | 0.0523 | 7 | 0.0105 | .00307 | 0.0393 | 0.00726 | 3 | 0.453 | 0.973 | 0.78 |
| 14 | 0.0299 | 0.0375 | 10 | 0.00608 | 0.00249 | 0.0269 | 0.00658 | 5 | 0.362 | 0.0684 | 0.05 |
| 21 | 0.14 | 0.00307 | 14 | 0.006 | 0.00162 | 0.0166 | 0.00442 | 7 | 0.0937 | 0.128 | 0.10 |
| | | | 21 | 0.00308 | 0.00045 | 0.00242 | 0.00116 | | | | |
| | | | 28 | -- | < LOQ | 0.00206 | | | | | |
| | | | 30 | 0.00124 | <LOQ | -- | 0.00061 | | | | |
| | | | 35 | 0.00108 | | 0.00163 | 0.00085 | | | | |
| GM 0-31(pred) | 0.0775 | 0.0132 | GM 0-35 | 0.00745 | 0.0023 | 0.0211 | 0.00234 | GM 0-31(pred) | 0.00158 | 0.00029 | 0.00023 |

NOTE: Bolded numbers were used in the postapplication assessments for short-term and intermediate-term residue values.

Table 10. Occupational Short- and Intermediate-Term Postapplication Risks for Atrazine

(Using DFR values from Atrazine corn study MRID No. 448836-01)

| Crop/Use Pattern | Application Rate (lb ai/acre) | Postapplication Activity | Transfer Coefficient ^a | Short Term Risks | | Intermediate Term Risks | |
|------------------|----------------------------------|-----------------------------------|-----------------------------------|---|------------------|--|------------------|
| | | | | DFR ^b (µg/cm ²) (DAT 0-1) | MOE ^c | DFR ^d (ug/cm ²) (DAT 0-31) | MOE ^e |
| Corn | 2 | Scout (minimum foliage) | 400 | 3.37 | 660 | 0.00158 | 3.5 e+05 |
| | | Irrigate, weed (minimum foliage) | 100 | 3.37 | 2,700 | 0.00158 | 1.4 e+06 |
| Conifer Forests | 4 | Scout (cruise, etc.) | 1,000 | 6.74 | 140 | 0.0032 | 7.1 e+05 |
| Sugarcane | 4 | Scout (full foliage) | 2,000 | 6.74 | 68 | 0.0032 | 35,000 |
| Sorghum | 2 | Scout, irrigate (minimum foliage) | 100 | 3.37 | 2,700 | 0.00158 | 1.4 e+06 |

- a Transfer coefficient from Science Advisory Council for Exposure: Policy Memo # 003 .1 “Agricultural Transfer Coefficients,” Revised - August 7, 2000.
- b DFR source: corn study MRID # 448836-01, DAT 0-1 residue unless an MOE of >100 was not reached. In such cases risks were assessed on days following application until an MOE of 100 was determined. The highest residue value occurring between DAT 0-1 was used for determination of DAT 1 MOE's. The highest residue values were detected after application of a 90 DF wettable powder formulation. The study was conducted using an application rate of 2.5 lb ai/acre. The residues were first normalized to reflect an application rate of 2.0 lb ai/acre to aid in determination of highest residues (i.e., the 90 DF vs 4L formulations). When assessing activities involving a different application rate than was used in the study, the DFR values were adjusted proportionately to reflect the different application rates. For example, for sugarcane, which has a maximum label rate of 4.0 lb ai/acre, adjusted DFR =
- Corn DFR x 4 lb ai/A for sugarcane
2 lb ai/A for corn
- c MOE = Short-term NOAEL (104 mg/kg/day; based on a dermal study) / dermal dose where dose = DFR (µg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) / body weight (70 kg adult).
- d DFR source: corn study MRID # 448836-01, geometric mean of predicted residues DAT 0-31. See footnote b for further explanation.
- e MOE = Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral developmental study) / absorbed dermal dose where absorbed dose = DFR (µg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 µg) x exposure time (8 hrs/day) x dermal absorption (6%) / body weight (60 kg developmental female).

Note: DFR = Dislodgeable Foliar Residue

Table 11: Occupational Short- and Intermediate-Term Postapplication Risks for Granular Atrazine Formulations on Turf
(Using TTR values from granular Atrazine turf study MRID No. 449588-01)

| Crop/Use Pattern | Application Rate (lb ai/acre) | Postapplication Activity | Transfer Co-efficient | Short-Term Risk Estimates | | | | Intermediate-term Risk Estimates | | | |
|----------------------|-------------------------------|---|-----------------------|--|------------|------------------|------------|---|------------|------------------|------------|
| | | | | TTR ^b (ug/cm ²) (DAT 0-1) | | MOE ^c | | TTR ^d (ug/cm ²) (DAT 0-31) | | MOE ^e | |
| | | | | FL (Non-irrig) | FL (Irrig) | FL (Non-irrig) | FL (Irrig) | FL (Non-irrig) | FL (Irrig) | FL (Non-irrig) | FL (Irrig) |
| Golf Course Turf | 2 | Mow, seed, scout, mechanical weed, aerate, fertilize, prune | 500 | 0.216 | 0.0744 | 8,400 | 25,000 | 0.0211 | 0.0023 | 6,100 | 55,000 |
| | | Transplant, high contact | 16,500 | 0.216 | 0.0744 | 250 | 750 | NA | NA | NA | NA |
| Sod Farms (FL) | 4 | Mow, scout, mechanical weed, irrigate | 500 | NA | | | | 0.0422 | 0.0047 | 3,200 | 28,000 |
| Sod Farms | 2 | Mow, scout, mechanical weed, irrigate | 500 | NA | | | | 0.0211 | 0.0023 | 6,100 | 55,000 |
| Macadamia Nuts/Guava | 4 | Mow, scout, irrigate (turf under the trees) | 500 | 0.432 | 0.15 | 4300 | 12,000 | 0.0422 | 0.0047 | 3,200 | 28,000 |

- a Transfer coefficient from Science Advisory Council for Exposure: Policy Memo # 003 .1 “Agricultural Transfer Coefficients,” Revised - August 7, 2000.
- b TTR source: granular atrazine to turf study MRID # 449588-01, DAT 0-1 residue. The highest residue value occurring between DAT 0-1 was used for determination of DAT 1 MOE's. The study was conducted in GA and FL using an application rate of 2.0 lb ai/acre. Average daily TTRs were higher at the FL site and those residues were used for the exposure estimates shown. When assessing activities involving a different application rate than was used in the study, the TTR values were adjusted proportionately to reflect the different application rates. For example, for turf on Florida muck, which has a maximum label rate of 4.0 lb ai/acre, adjusted TTR =
Turf TTR x 4 lb ai/A for Florida muck
2 lb ai/A for turf
- c $MOE = \text{Short-term NOAEL (104 mg/kg/day; based on a dermal study)} / \text{dermal dose where absorbed dose} = TTR (\mu\text{g/cm}^2) \times TC (\text{cm}^2/\text{hr}) \times \text{conversion factor (1 mg/1,000 } \mu\text{g)} \times \text{exposure time (8hrs/day)} / \text{body weight (70 kg; adult)}.$
- d TTR source: granular atrazine turf study MRID # 449580-01, geometric mean of actual residue data DAT 0-35. See footnote b for further explanation.
- e $MOE = \text{Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral developmental study)} / \text{absorbed dermal dose where absorbed dose} = TTR (\mu\text{g/cm}^2) \times TC (\text{cm}^2/\text{hr}) \times \text{conversion factor (1 mg/1,000 } \mu\text{g)} \times \text{exposure time (8 hrs/day)} \times \text{dermal absorption (6 \%)} / \text{body weight (60 kg; developmental female)}.$
- NA = Not applicable to this scenario based on typical application and postapplication activities.
- TTR - Turf Transferable Residue

Table 12. Occupational Short- and Intermediate-Term Postapplication Risks for Liquid Atrazine Formulations Applied to Turf

(Using TTR values from liquid Atrazine turf study MRID No. 449580-01)

| Crop/Use Pattern | Application Rate (lb ai/acre) | Postapplication Activity | Transfer Coefficient ^a (TC) | Short Term Risks | | | | Intermediate Term Risks | | | |
|----------------------|----------------------------------|--|---|--|---------------|------------------|-------|---|--------|------------------|------|
| | | | | TTR ^b (ug/cm ²) (DAT 0-1) | | MOE ^c | | TTR ^d (ug/cm ²) (DAT 0-31) | | MOE ^e | |
| | | | | GA | NC | GA | NC | GA | NC | GA | NC |
| Golf Course Turf | 2 | Mow, seed, scout, mechanical weed, aerate, fertilize | 500 | 0.241 | 1.32 (wet) | 7,500 | 1,400 | 0.0775 | 0.0132 | 1700 | 9800 |
| | | Transplant, high contact | 16,500 | 0.241 | 0.219 | 230 | 250 | NA | NA | NA | NA |
| Sod Farms (FL) | 4 | Mow, scout, mechanical weed, irrigate | 500 | 0.482 | 2.64 | NA | NA | 0.155 | 0.0264 | 840 | 4900 |
| Sod Farms | 2 | Mow, scout, mechanical weed, irrigate | 500 | 0.241 | 1.32 | NA | NA | 0.0775 | 0.0132 | 1700 | 9800 |
| Macadamia Nuts/Guava | 4 | Mow, scout, irrigate (turf under the trees) | 500 | 0.482 | 2.64 | 3,800 | 690 | 0.155 | 0.0264 | 840 | 4900 |

a Transfer coefficient from Science Advisory Council for Exposure: Policy Memo # 003 .1 "Agricultural Transfer Coefficients," Revised - August 7, 2000.

b TTR source: liquid atrazine to turf study MRID # 449580-01, DAT 0-1 residue unless an MOE of >100 was not reached. In such cases risks were assessed on days following application until an MOE of 100 was determined. The highest residue value occurring between DAT 0-1 was used for determination of DAT 1 MOE's. The study was conducted in GA and NC using an application rate of 2.0 lb ai/acre. When assessing activities involving a different application rate than was used in the study, the TTR values were adjusted proportionately to reflect the different application rates. For example, for sod grown in Florida muck, which has a maximum label rate

of 4.0 lb ai/acre, adjusted TTR =
$$\frac{\text{Turf TTR} \times 4 \text{ lb ai/A for sod} \in \text{Florida muck}}{2 \text{ lb ai/A for turf}}$$

c MOE = Short-term NOAEL (104 mg/kg/day; based on a dermal study) / dermal dose where dose = TTR (μg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 μg) x exposure time (8 hrs/day) / body weight (70 kg adult).

d TTR source: liquid atrazine turf study MRID # 449580-01, geometric mean of DAT 0-31 predicted residue. See footnote b for further explanation.

e MOE = Intermediate-term NOAEL (1.8 mg/kg/day; based on an oral developmental study) / absorbed dermal dose where absorbed dose = TTR (μg/cm²) x TC (cm²/hr) x conversion factor (1 mg/1,000 μg) x exposure time (8 hrs/day) x dermal absorption (6%) / body weight (60 kg female).

NA = Not applicable to this scenario based on typical application or postapplication activities.

TTR = Turf Transferable Residue

Table 13: Residential Exposure Scenario Descriptions for the Use of Atrazine

| Exposure Scenario (Number) | Data Source | Standard Assumptions ^a | Comments ^b |
|--|---|--|--|
| Mixer/Loader/Applicator Descriptors | | | |
| Backpack Sprayer (R1) | SOPs for Residential Exposure Assessments (12/-97, rev. 2/01) | 0.023 acres (1000 ft ²) for spot treatment | Baseline: Dermal (9-11 replicates) exposure value is based on AB grade data, hand (11 replicates) exposure value is based on C grade data, and inhalation (11 replicates) exposure value is based on A grade data. Low confidence in hands/dermal and inhalation data. A 90% protection factor was used to “back calculate” the “no glove” hand scenario from gloved hand data. |
| Low Pressure Handwand - Liquid Formulations (R2) | SOPs for Residential Exposure Assessments (12/-97, rev. 2/01) | 0.023 acres (1000 ft ²) for spot treatment | Baseline: Dermal (9-80 replicates) and inhalation (80 replicates) exposure values are based on ABC grade data, and hand (70 replicates) exposure value is based on All grade data. Low confidence in hand/dermal data. Medium confidence in inhalation data. |
| Granulars with a Bellygrinder (R3) | SOPs for Residential Exposure Assessments (12/-97, rev. 2/01) | 0.5 acres for broadcast; 0.023 acres (1,000 ft ²) for spot treatment | Baseline: Dermal (20-45 replicates) and Hand (23 replicates) exposure values are based on ABC grade data. Inhalation (40 replicates) exposure value is based on AB grade data. Medium confidence in dermal/hand data and high confidence in inhalation data. |
| Hose-End Sprayer (R4) | ORETF Study - OMA004 | 0.5 acres | Baseline: Dermal, hand and inhalation (30 replicates each for long sleeved, long pants scenario) data used to establish exposure values. High confidence. May use instead of low-confidence PHED v.1.1 data. |
| Push-type Granular Spreader (R5) | ORETF Study - OMA003 | 0.5 acres | Baseline: Hand, dermal, and inhalation (30 replicates each) data used to establish exposure values. High confidence. |

^a Standard Assumptions based on Residential SOPs and HED estimates.

^b "Best Available" grades are defined by HED SOP for meeting Subdivision U Guidelines. Best available grades are assigned as follows: matrices with grades A and B data and a minimum of 15 replicates; if not available, then grades A, B and C data and a minimum of 15 replicates; if not available, then all data regardless of the quality and number of replicates. Data confidence are assigned as follows:

High = grades A and B and 15 or more replicates per body part

Medium = grades A, B, and C and 15 or more replicates per body part

Low = grades A, B, C, D and E or any combination of grades with less than 15 replicates

Table 14a. Residential Short-term Handler Risks to Atrazine at Baseline

| Exposure Scenario | Crop Type/Use | Application Rate ^a (lb ai/acre) | Amount Handled per Day ^b (acres) | PHED Unit Exposure | | Daily Dose | | MOEs | | |
|--|---------------|---|---|-----------------------------------|---------------------------------------|------------------------------------|--|---------------------|-------------------------|----------|
| | | | | Dermal ^c (mg/lb ai) | Inhalation ^d (µg/lb ai) | Dermal ^e (mg/kg/day) | Inhalation ^f (mg/kg/day) | Dermal ^g | Inhalation ^h | Combined |
| Mixer/Loader/Applicator | | | | | | | | | | |
| Backpack Sprayer (R1) | lawns | 2 | 0.023 | 5.1 | 30 | 0.0034 | 0.000020 | 31,000 | 320,000 | 28,000 |
| Low Pressure Handwand - Liquid Formulations (R2) | lawns | 2 | 0.023 | 100 | 30 | 0.066 | 0.000020 | 1,600 | 320,000 | 1,600 |
| Granulars with a Bellygrinder (R3) | lawns | 2 | 0.5 0.023 [spot] | 110 | 62 | 1.6 | 0.00089 | 66 | 7,100 | 65 |
| | | | | | | 0.072 | 4.10e-05 | 1,400 | 150,000 | 1,400 |

Footnotes:

a Application rates are the maximum application rates determined from EPA registered labels.

b Amount handled per day values are EPA estimates of acreage treated, as found in the Residential SOPs draft December 1997; 0.5 acre lawn or 1000 ft² (0.023) acre spot treatment..

c Dermal unit exposure values from Residential SOPs draft December 1997. Baseline dermal exposure assumes short pants, short sleeved shirt, and no gloves. All scenarios are considered mixer/loader/applicators.

d Inhalation unit exposure values from the Residential SOPs draft December 1997 representing a no respirator scenario.

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult).

f Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (70 kg adult).

g Dermal MOE = NOAEL (104 mg/kg/day based) / daily dermal dose (mg/kg/day)..

h Inhalation MOE = NOAEL (6.25 mg/kg/day) / daily inhalation dose (mg/kg/day).

Table 14b. Residential Short-term Handler Risks to Atrazine at Baseline (Using ORETF Unit Exposure Values)

| Exposure Scenario | Crop Type/Use | Application Rate ^a (lb ai/acre) | Amount Handled per Day ^b (acres) | ORETF Unit Exposure | | Daily Dose | | MOEs | | |
|--|---------------|---|---|-----------------------------------|---------------------------------------|------------------------------------|--|---------------------|-------------------------|----------|
| | | | | Dermal ^c (mg/lb ai) | Inhalation ^d (µg/lb ai) | Dermal ^e (mg/kg/day) | Inhalation ^f (mg/kg/day) | Dermal ^g | Inhalation ^h | Combined |
| Mixer/Loader/Applicator | | | | | | | | | | |
| Hose-end (Dial-Type) Sprayer (R4) | lawns | 2 | 0.5 | 11 | 16 | 0.16 | 0.00023 | 660 | 27,000 | 640 |
| Granulars with a Push Type Spreader (R5) | lawns | 2 | 0.5 | 0.68 | 0.91 | 0.0097 | 1.30e-05 | 11,000 | 480,000 | 11,000 |

Footnotes:

a Application rates are the maximum application rates determined from EPA registered labels.

b Amount handled per day values are EPA estimates of acreage treated found in the Residential SOPs draft December 1997. Baseline dermal exposure assumes short pants, short sleeved shirt, and no gloves clothing scenario. All scenarios are considered mixer/loader/applicators.

c Dermal unit exposure values from 2 Outdoor Residential Exposure Task Force ORETF (MRID 449722-01: ORETF Study Numbers OMA003, OMA004) studies. Homeowner exposure was assessed in this table using a short sleeved shirt, short pants, no glove clothing scenario.

d Inhalation unit exposure values from the same ORETF studies cited in footnote c representing “no respirator” scenarios.

e Dermal daily dose (mg/kg/day) = daily unit exposure (mg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) / body weight (70 kg adult).

f Inhalation daily dose (mg/kg/day) = inhalation unit exposure (µg/lb ai) x application rate (lb ai/acre) x amount handled per day (acres/day) x conversion factor (1 mg/1,000 µg) / body weight (70 kg adult).

g Dermal MOE = NOAEL (104 mg/kg/day) / daily dermal dose (mg/kg/day).

h Inhalation MOE = NOAEL (6.25 mg/kg/day) / daily inhalation dose (mg/kg/day).

Table 15. Residential Short-term Dermal Postapplication Risks for Atrazine

(Using TTR values from liquid and granular Atrazine turf studies - MRID Nos. 449580-01, 449588-01)

| Dermal Scenarios | Exposure Time (hours/day) | Short Term Risks | | | | | | |
|-----------------------------|---------------------------|---|-------------------|---------|-----------|-----------|-------------|--------|
| | | Transfer Coefficient ^a (cm ² /hr) | MOEs ^c | | | | | |
| | | | GA granular | | GA liquid | NC liquid | FL granular | |
| | | | Non-irrig. | Irrig. | | | Non-irrig. | Irrig. |
| Adult dermal turf contact | 2 | 14,500 | 4300 | 21,000 | 1000 | 190 | 1200 | 3400 |
| Child dermal turf contact | 2 | 5,200 | 2600 | 13,000 | 620 | 110 | 690 | 2000 |
| Adult walking, playing golf | 4 | 500 | 62,000 | 310,000 | 15,000 | 2800 | 17,000 | 49,000 |
| Adult push mowing lawn | 2 | 500 | 120,000 | 620,000 | 30,000 | 5,500 | 34,000 | 98,000 |

a Transfer coefficient from revisions to Residential SOP's (02/01).

b TTR source: liquid and granular turf studies MRID # 449580-01, 449588-01, DAT 0-1 residue (see Table 10). The highest average residue value during any time period following application to DAT 1 was used for determination of DAT 0-1 MOE's. The highest residue values were detected on damp turf after liquid application of a 90 DF formulation. All formulations in the studies were applied at a rate of 2 lb ai/acre.

c $MOE = \text{Short-term NOAEL (104 mg/kg/day)} / \text{dermal dose where dermal dose} = \text{TTR } (\mu\text{g/cm}^2) \times \text{TC (cm}^2/\text{hr)} \times \text{conversion factor (1 mg/1,000 } \mu\text{g)} \times \text{exposure time (2 hrs/day)} / \text{body weight (70 kg adult or 15 kg 1- to 6-year-old)}.$

Note: TTR = Turf Transferable Residue

Table 16: Granular Atrazine Treated Turf: Hand Press Transfer Efficiency Study Residue Data
[MRIDs 45622310, 4562311]

| Scenario | Number of Hand Presses | Residue Transferred to Hands | |
|------------------------------|------------------------|--|--|
| | | Atrazine Residue ($\mu\text{g}/\text{cm}^2$) | Percent of Application Rate ^a |
| Dry palm; non-irrigated turf | 1 | 0.058 | 0.26 |
| | 7 | 0.12 | 0.53 |
| Dry palm; irrigated turf | 1 | 0.0093 | 0.041 |
| | 7 | 0.059 | 0.26 |
| Wet palm; non-irrigated turf | 1 | 0.24 | 1.1* |
| | 7 | 0.25 | 1.1* |
| Wet palm; irrigated turf | 1 | 0.015 | 0.068 |
| | 7 | 0.048 | 0.21 |

*arithmetic mean of data for both wet palm residue transfer sets; data were analyzed by two-sample t-test and determined to be normal distribution and no significant difference between the means of the single and seven-press data sets

^aTurf in study was treated with 2 lb ai/acre granular formulation of atrazine.

Table 17. Residential Short-term Oral Nondietary Postapplication Risks to Children (1-6) from “Hand-to-Mouth” and Ingestion Exposure When Reentering Lawns Treated with Granular or Liquid Atrazine Formulations

| Type of Exposure | | Application Rate ^a (lb ai/acre) | Ingestion Rate or Other Assumptions ^b | Oral Dose ^d (mg/kg/day) | ^c MOE ^c |
|--|----------|---|--|---------------------------------------|----------------------------------|
| Hand to Mouth Activity | liquid | 2 | Residential SOPs | 0.030 | 210 |
| | granular | | Atrazine Granular Hand-Press Study | 0.0066 | 950 |
| Turfgrass/Object Mouthing | | 2 liquid or granular | Residential SOPs | 0.0019 | 3300 |
| Ingestion of Soil | | 2 liquid or granular | Residential SOPs | 1.0E-4 | 62,500 |
| Total of the Oral Exposures Above ^f | | Liquid formulation | | 0.032 | 200 |
| | | Granular formulation | | 0.0086 | 730 |
| Incidental Ingestion of Granules | 0.42% ai | 0.2-0.4 g/day (100-200 lbs formulation /acre) | | 0.056-0.11 | 57-110 |
| | 1.5% ai | | | 0.2-0.4 | 16-31 |

Footnotes:

- a Application rates represent maximum label rates from current EPA registered labels.
b Assumptions from Draft Residential SOP's (1997, revised 2/01).
c TTR source: liquid and granular atrazine turf studies MRID Nos. 449580-01; 449588-01. Short-term risks assessed using DAT 0-1 residue values.
d Oral doses calculated using formulas presented in the Residential SOPs (December, 1999). Short-term doses were calculated using the following formulas.

Hand-to-mouth:

in the absence of DFR data, Revised Residential SOPs (02/01) are used:

oral dose to child (1-6 year old) on the day of treatment (mg/kg/day) = [application rate (lb ai/acre) x fraction of residue dislodgeable with potentially wet hands (5%) x 11.2 (conversion factor to convert lb ai/acre to µg/cm²)] x median surface area for 1-3 fingers (20 cm²/event) x hand-to-mouth rate (ST: 20 events/hour) x 50% saliva extraction factor x exp. time (2 hr/day) x 0.001 mg/µg] / bw (15 kg child).

For granular formulations, the atrazine granular hand-press study data (MRIDs 45622310, 45622311) were used: the average moistened hand-mouth granular residue transfer rate of 1.1% of the ai application rate.

Grass/object mouthing: oral dose to child (1-6 year old) on the day of treatment (mg/kg/day) = [application rate (lb ai/acre x 11.2 (conversion factor to convert lb ai/acre to µg/cm²)) x fraction of residue dislodgeable (5%) x ingestion rate of grass (25 cm²/day) x .001 mg/µg] / bw (15 kg child).

Soil ingestion: oral dose to child (1-6 year old) on the day of treatment (mg/kg/day) = [(application rate (lb ai/acre) x fraction of residue retained on uppermost 1 cm of soil (100% or 1.0/cm) x 4.54E+08 µg/lb conversion factor x 2.47E-08 acre/cm² conversion factor x 0.67 cm³/g soil conversion factor) x 100 mg/day ingestion rate x 1.0E-06 g/µg conversion factor] / bw (15 kg). Short term dose based residue on the soil on day of application.

Granular pellet ingestion: (mg/kg/day) oral dose to child (1-6 year old) = [Granule ingestion rate (0.2-0.4 g/day) x Fraction of ai of granule formulations x 1,000 mg/g] / bw (15 kg).

- e Oral MOE = Oral NOAEL (6.25 mg/kg/day for short-term assessments) / Oral Dose (mg/kg/day). Oral NOAEL determined from a rat study. MOEs are reported to two significant figures; target MOE is at least 300.
f Combined MOE may be obtained by dividing oral NOAEL by sum of oral doses, or by taking the inverse of the sum of the inverses of the MOEs:

$$\text{Combined MOE} = 1/[1/\text{MOE}_1 + 1/\text{MOE}_2 \text{ etc.}]$$